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# THE MANUAL ARTS
## FOR ELEMENTARY SCHOOLS
## DRAWING · DESIGN · CONSTRUCTION

C. S. HAMMOCK
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SHOP WORK

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# AUTHOR'S NOTE

This book is intended not as a complete treatise on wood and metal working, but as a guide for upper grammar grade and high school pupils in working out certain problems in metal and wood. The problems selected are typical of useful articles which boys enjoy making, and the methods of working are in harmony with those of the best workmen. Classes need not be limited to the making of the articles described, as all the usual processes needed in the making of any ordinary object are embodied in the various problems in the book. The authors realize that many of the problems may be rather too difficult for grammar grade pupils, but they have put them in with the understanding that this book will be used by a great many high school students. In cases where the problems seem too difficult for grammar grades, similar things of a simpler nature may be substituted. In fact it is taken for granted that the instructor will supply the simpler projects which he finds best adapted to his classes. Inasmuch as simpler problems are given in the *other books* of this series it seems unnecessary to repeat them here. They appear as follows: Fifth Year Book, pages 24, 25, 28, 30, 32, 34; Sixth Year Book, pages 30, 32, 34; Seventh Year Book, pages 16, 30, 34; Eighth Year Book, pages 29, 30, 32, 34, 35.

C. S. H. and A. G. H.

Boston, January, 1910.

# SHOP WORK

## GENERAL PLAN OF THE BOOK

The work given in this book is not arranged according to any special scheme of work, and in many cases the exercises taken up are so independently planned that they may be used in almost any order. The first part of the book is devoted to wood-working and the latter part to thin metal-working. Practice in using tools for the mere sake of practice is not considered worth while, as, for instance, simply sawing for the sake of learning to saw. It is considered very much better to use the tools in making objects even while learning the various operations. The work, therefore, begins with projects instead of exercises. These projects bring the tool operations into use as nearly as seems possible in the order of their ease in execution and understanding.

It is not considered necessary to enter into any lengthy discussion about the arrangement of tools upon the bench or about the arrangement and care of the work-shop, inasmuch as this book is intended to *supplement*, and not *supplant*, the work of the instructor. It is considered essential, however, to give some attention to the structure and use of the various tools. The section of the book, then, upon "tools and operations" should be referred to often, and should be studied carefully whenever any new tool or new operation is to be taken up.

In working out problems in wood the following processes are involved:

1. Laying out stock.
2. Dressing up stock.
3. Assembling.
4. Finishing.

### 1. LAYING OUT STOCK

The process of marking out upon the material at hand the different pieces before cutting them out is called laying out stock. Select the lumber to be used and mark out on this, by the aid of rule and try-square, as many of the required pieces as possible, allowing ¼ to ½ inch on each dimension for dressing. After more facility is acquired in the use of tools a smaller margin may be allowed. Before beginning to construct an object a stock list should be made, showing just how many pieces are needed and the exact size of each. As you lay out the pieces check them from the stock list. After laying out all parts, proceed to saw them all out before beginning to dress up. Use cross-cut saw for all cuts across the grain, and the rip-saw for cutting with the grain.

### 2. DRESSING UP STOCK

The steps to be taken in dressing up a piece of stock are:

1. Dress one side (face side).
2. Dress one edge (joint edge), at right angles with face side.
3. From joint edge measure width and dress opposite edge.
4. Square one end with joint edge and dress end.

5. Measure length from this squared end. Square and dress opposite end.

6. Mark thickness on all edges from face side and dress opposite side down to the mark.

Follow this order of procedure with each piece, and dress up all pieces before beginning to assemble.

## 3. ASSEMBLING

With the drawing before you proceed to assemble, or put together, the parts. No general directions can be given for assembling, inasmuch as the different articles will be assembled in different ways. Refer to the instruction given for assembling the stool on page 19.

## 4. FINISHING

If the tool work has been done with sufficient care no sandpaper will be necessary, except to remove the finger marks or stains. Sandpaper is not a cutting tool and must not be used to obliterate evidence of careless tool work. A surface left by the sharp edge of a cutting tool is preferable to a surface that has been sandpapered. After all spots or stains have been removed from the surface it should be very carefully dusted, leaving it clean and free from loose particles of sand or dust. Apply any suitable stain or finish. (See page 9.)

# TOOLS AND OPERATIONS

In order to use tools with proficiency it is necessary to know their structure and various uses. The structure of a tool depends, of course, upon the use to which it is put, and by gaining a thorough understanding of both one will be enabled to get the greatest good from a tool, and to avoid using one tool for a purpose for which some other is better adapted.

For convenience in study, we may divide wood-working tools into three general classes; the laying-out tools, cutting tools, and general, or miscellaneous, tools.

The laying-out tools used for measuring and marking in general use are the rule, try-square, marking gauge, framing square, bevel and knife.

RULE. Any ordinary 12-inch rule, graduated to 16ths of an inch, will answer the purpose. It should be understood by the student that a rule is to be used for no other purpose than measuring, and in measuring the distance should be set off by using a very sharp pencil or the point of a knife, preferably the latter. It is well not to measure from the end of a rule, but to begin on one of the divisions away from the end, as the corner of a rule may become slightly jammed and therefore inaccurate. Figure 1 shows


Fig. 1.

the method of using a knife in setting off measurements on a rule. The back of the blade should be turned toward the rule, the knife held vertically and tightly against the edge of the rule. In this way a very accurate measurement may be made.

TRY-SQUARE. For drawing lines the try-square (or the framing square) should be used. The lines may be drawn with a pencil, or may be scored with a knife. In working across the grain scoring with a knife will be found more satisfactory. Acquire the habit of marking or scoring once only, instead of making several scratches as is sometimes done. Make up your mind in the beginning that you are going to be accurate in your work and you are likely to do such work as can be depended upon. Fix a standard in your mind that nothing is *good enough* unless it is right. You need not then remeasure a piece of stock several times to be sure that it is right.

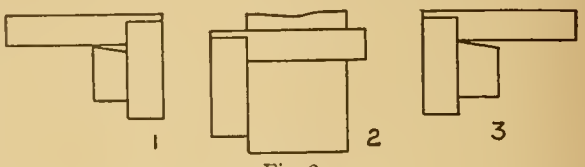


Fig. 2

In using a square, see that the beam is held firmly against the stock and not allowed to slip while the scoring is done. The try-square has many uses, aside from those described. In laying out and dressing up stock the try-square plays an important part. It is used to test edges, ends and sides of boards, as shown in Figure 2. If it is desired to cut off a board, it is necessary to mark entirely around it with the knife and try-square. After the piece is sawed off the try-square is again used to test the straightness and accuracy of the cut. If any block planing or other cutting is necessary to render the cut straight, the try-square is the instrument that is used to determine it.

FRAMING SQUARE. The structure of the framing square is similar to that of the try-square, except that it is larger, and instead of having a thick beam like the try-square it is the same thickness as the blade, and is used only for large work.

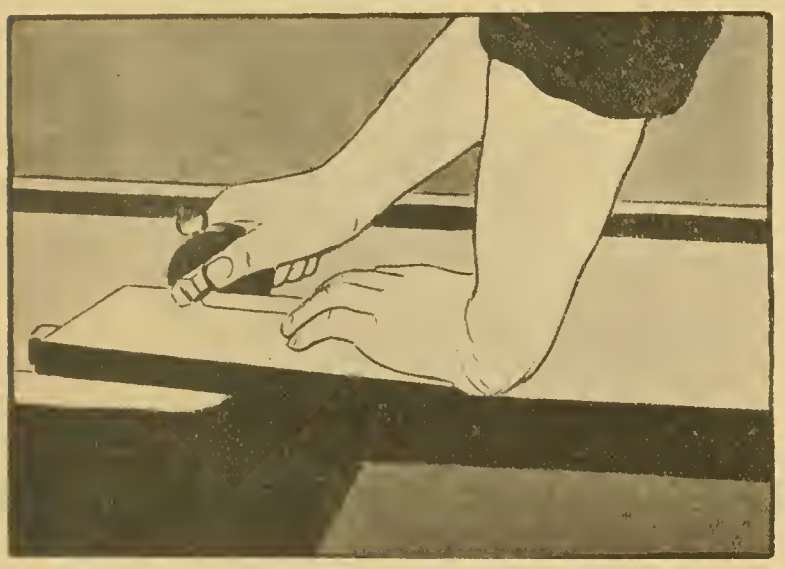


Fig. 3

THE MARKING GAUGE. The use of the marking gauge is shown in Figure 3. In setting off the distance on the gauge use the rule, and not the graduated scale upon the gauge, as the rule is more likely to be accurate. Place the end of the rule against the block of the gauge and slide the bar through the block until the marking point of the gauge coincides with the point upon the rule which indicates the distance desired. Turn the set screw in the block, being careful not to change its position, and the gauge is set ready for use. The thumb and forefinger should encircle the gauge block when it is used, and the tool should be tipped from you until the spur, or marking point, barely touches the wood. The line made by the gauge should be as fine as a knife or pencil line. Note that the gauge is always moved from you.

THE BEVEL. The bevel is similar to the try-square, differing only in that it has a movable blade which can be set at any desired angle. It is used in laying off angles of various degrees, and in the same manner as the try-square. The blade is loosened by turning the set screw to the left, and after the blade is set at the proper angle the set screw is tightened, after which it is ready for use.

# CUTTING TOOLS

The tools coming under this heading are saws of various kinds, planes, chisels, augur-bits, spoke-shaves, drawing knife, hatchet and knife. The cutting tools themselves may be divided into two classes, — those with toothed edges and those with smooth edges.

SAWS. The tooth-edged tools are saws, of which there are many varieties, — the most common being the rip-saw for cutting with the grain, and the cross-saw for cutting against it. If the cutting edge of the rip-saw were enlarged sufficiently, it would be apparent to the eye that it is merely a succession of chisels set in such position that they cut at right angles to the wood fibres. Alternating teeth are bent inward and outward sufficiently to make the cut, or kerf, of the saw wide enough for the blade to pass through freely. Compare carefully the structure of the teeth of cross-cut and rip-saws.

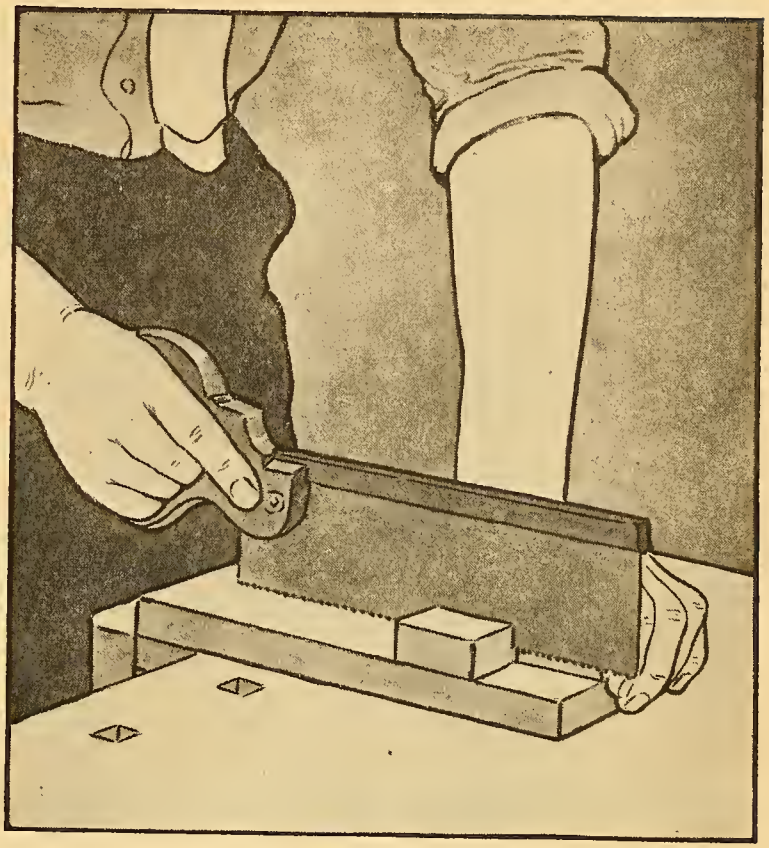


Fig. 4

THE BACKSAW is a cross-cut saw with small teeth and a strip of steel reinforcing the back, in order to insure a straight cut in doing accurate small work. On account of the thinness of the blade this steel back is necessary to prevent bending. While the backsaw is primarily a cross-cut saw, it will cut in any direction of the grain. Figure 4 shows a backsaw, in use, and the method of holding the small piece of stock by means of a bench hook. This bench hook is secured in the vise in order to hold it firmly and the stock is held against one of the cleats while the sawing is done. (On page 13 is a working drawing of a bench hook.)

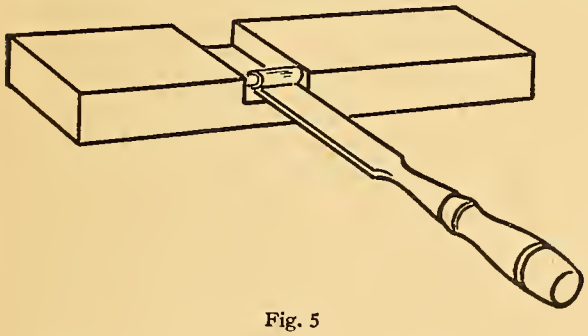


Fig. 5

THE TURNING SAW. The other saw in common use is the turning saw which may be used in any direction of the grain, and, as its name suggests, it is used where the cut is not straight. The blade being very narrow, it can be turned readily in any direction.

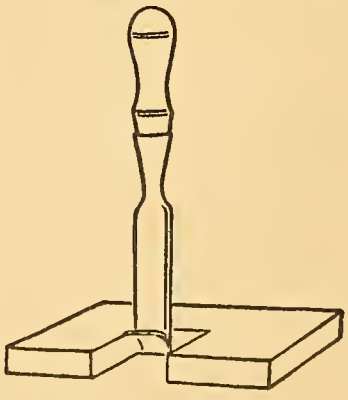


Fig. 6

EDGED TOOLS. In this class are the knife, chisels, hatchets and planes.

The chisel is perhaps the simplest form of cutting tool. They are of various sizes, ranging from ⅛ of an inch in width to 2 or 3 inches in width, depending upon the purpose for which they are intended. For ordinary work chisels of the following dimensions will answer all purposes, — ½, ¼, ¾ and 1 inch, — although

larger ones, up to 2 inches, should be kept in the general tool stock. The cutting angle of the tool depends upon the kind of wood to be cut. The harder the wood, the greater the angle; usually, for ordinary purposes, about 30 to 35 degrees. Care should be taken in sharpening the chisel not to disturb the angle or to round it off. The chisel is either pushed by the hands or driven with a wooden mallet. It seems almost needless to say that all chisels should be kept in good cutting condition if good work is expected. Form the habit early of keeping all edged tools sharp. It is impossible for good work to be done with a tool that is not in good condition. Figures 5 and 6 show the proper position of the chisel for horizontal and vertical cuts. It is well to use the largest tool that will conveniently do the work.

PLANES. A plane is simply a chisel set in a frame and used to pass over a board to remove a certain portion of the surface. The depth of the cut is regulated by a screw at the back of the plane and the frame of the plane keeps the depth of the cut uniform. By releasing the clamp (see fig. 7), the blade and cap are readily removed. Figure 8 shows the position of the jackplane in use. The blade should be sharpened in the same manner as a chisel, and care should be taken not to allow the corners to become rounded. After sharpening the plane blade test it with a try-square to see if the cutting edge is at right angles to the blade. If not, one side of the cut will be deeper in the wood. It is poor policy to attempt to hurry any tool in doing its work by setting the cut too deep. The same is true of sawing when one attempts to hurry the saw by means of pressure.

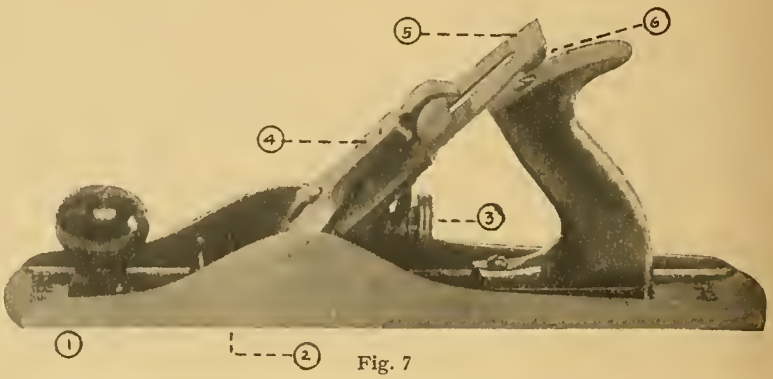



Fig. 7

This is from a photograph of a jackplane. 1 indicates the toe; 2, the mouth; 3, the screw, which regulates the depth of the cut; 4, the clamp, which holds the blade in place; 5, the blade, and 6, the lever by means of which the blade is kept straight — that is, one side as high as the other.

For ordinary work the plane most used is the jackplane, which is used for roughing out stock. (Figure 7 shows the structure of the jackplane.) The other planes are the smooth-plane, the jointer and the block-plane. The block-plane is used for very small work and for working across the grain. Figure 9 shows the block-plane in use. The smooth-plane is smaller than the jackplane and is used for smoothing the surface without reference to straightening it. The jointer is a long plane used for finishing and straightening the surface of the stock.

BRACE AND BIT. Figure 10 shows the position of the bit and brace in boring. It is necessary only to hold the tool vertical and turn the brace, without pressure on the bit.

Fig. 8

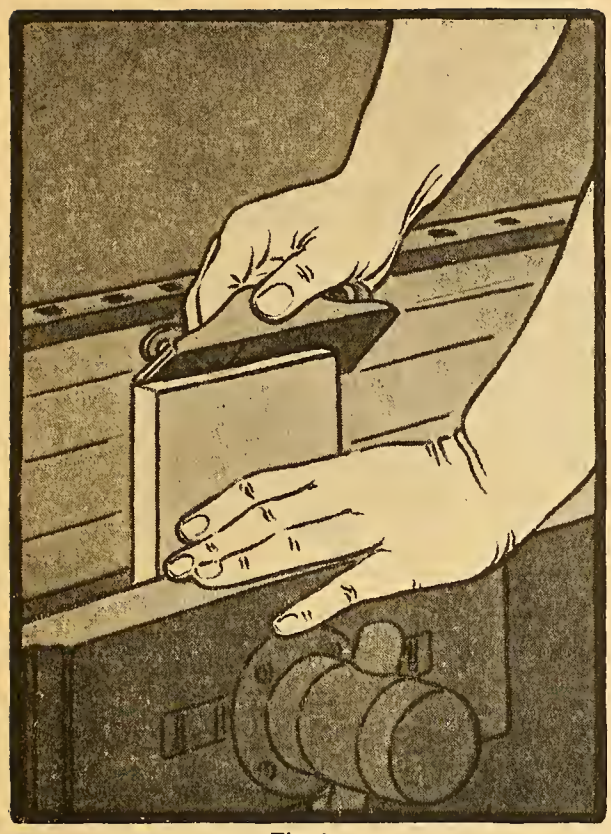


Fig. 9

Fig. 10

# JOINTS IN COMMON USE

It is not considered worth while to teach the making of joints abstractly for the purpose of gaining skill in making joints. It is thought better to learn to make each joint as the use for it develops in the making of objects. But for the convenience of the student when use for a joint does arise we have given on page 8 drawings of all the more important joints in common use. They are known by the following names:

1. Butt.
2. Corner Butt.
3. Lap Butt.
4. Mitred Lap Butt.
5. Gained.
6. Plain Mitre.
7. End Half Lap.
8. Lap.
9. Lap.
10. Half Lap.

11 and 12. Mortise and Tenon.

13. Blind Mortise and Tenon.
14. End Mortise and Tenon.

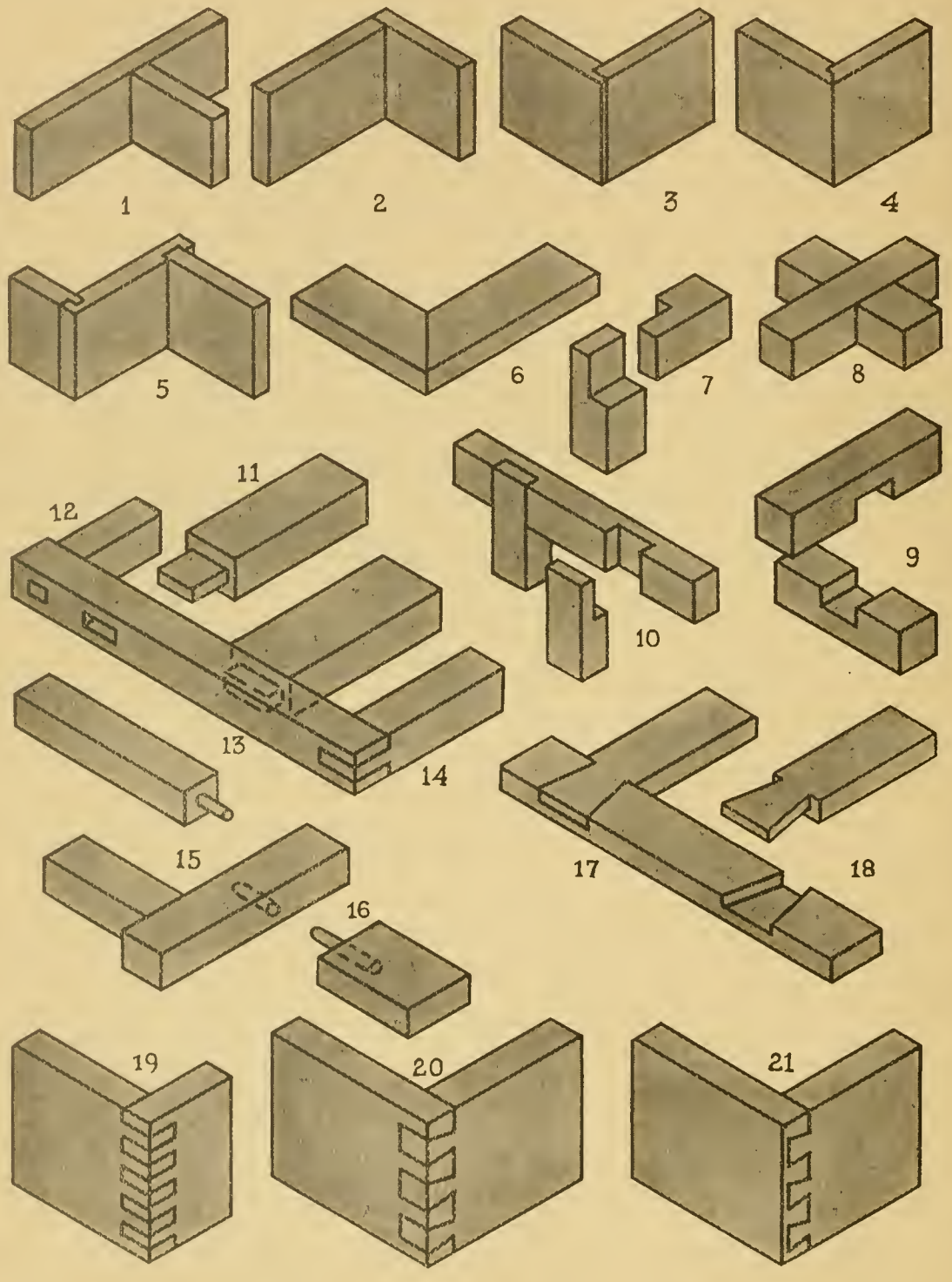
15 and 16. Dowel.

17 and 18. Dovetailed Half Lap.

19. Notched.
20. Plain Dovetail.
21. Half Blind Dovetail.

NOTE. — The student should apply to his instructor for the necessary information about how to lay out and cut the various joints.

# JOINTS IN COMMON USE



# STAINING AND FINISHING

For the purpose of this book it is not necessary to go into any lengthy discussion of stains and finishes. The authors feel that it will suffice to give a few of the more common ones, inasmuch as the instructor will be able to help the student on any particular stain or finish which he might desire. Perhaps the most satisfactory way for stains in general to be made is to take dry color, ground in oil, and mix it with boiled linseed oil to the consistency of paste. It may then be thinned with turpentine and applied with a brush. The stain should be wiped off immediately after it is applied. A great variety of colors may be obtained in this way, and where a particular color is to be matched this is the most practical method. Many of the stains already in the market are good, but they are likely to be rather harsh in color. If only small articles are to be stained, artists' oil colors in tubes, thinned with turpentine, are very satisfactory. They are expensive, however, and should not be used for large jobs. A very desirable finish, which may be applied over any kind of stain, is obtained by melting bees' wax in turpentine and applying it very hot to the wood. It should be rubbed with waste or an old cloth while it is hot. If too much wax is left upon the surface the finish will not be satisfactory. This finish might be repeated after several days if the surface seems to require it. This wax finish is very suitable for all indoor work. For out-door work, such as porch furniture, an oil finish is better.

## OIL FINISH

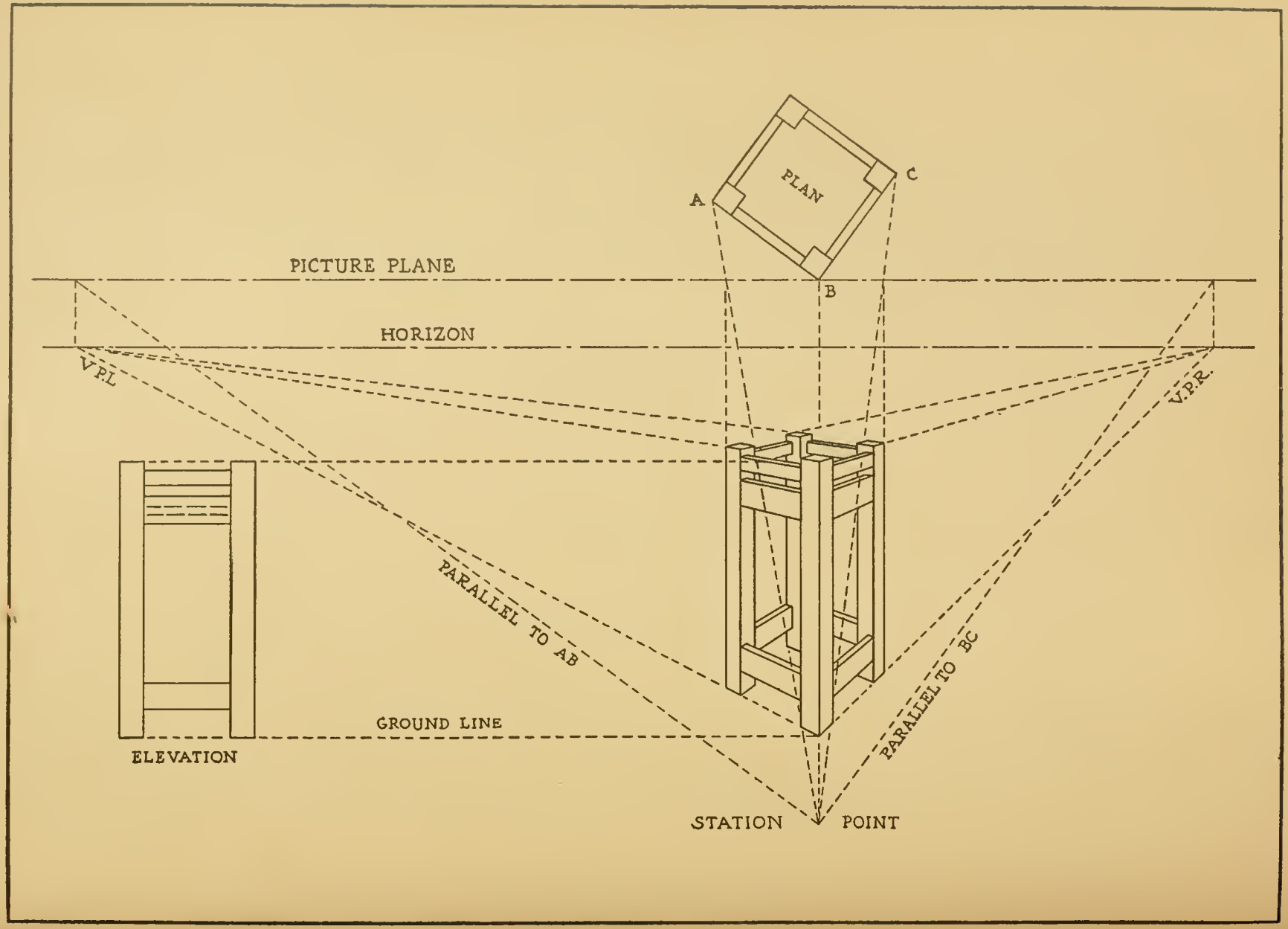
Cover the surface of the wood with boiling hot linseed oil and allow to dry for about twenty-four hours. This operation may be repeated three or four times, until the surface of the wood is thoroughly saturated. The color of the wood will be somewhat darkened and the oil will act as a preservative for the wood.

## SANDPAPER

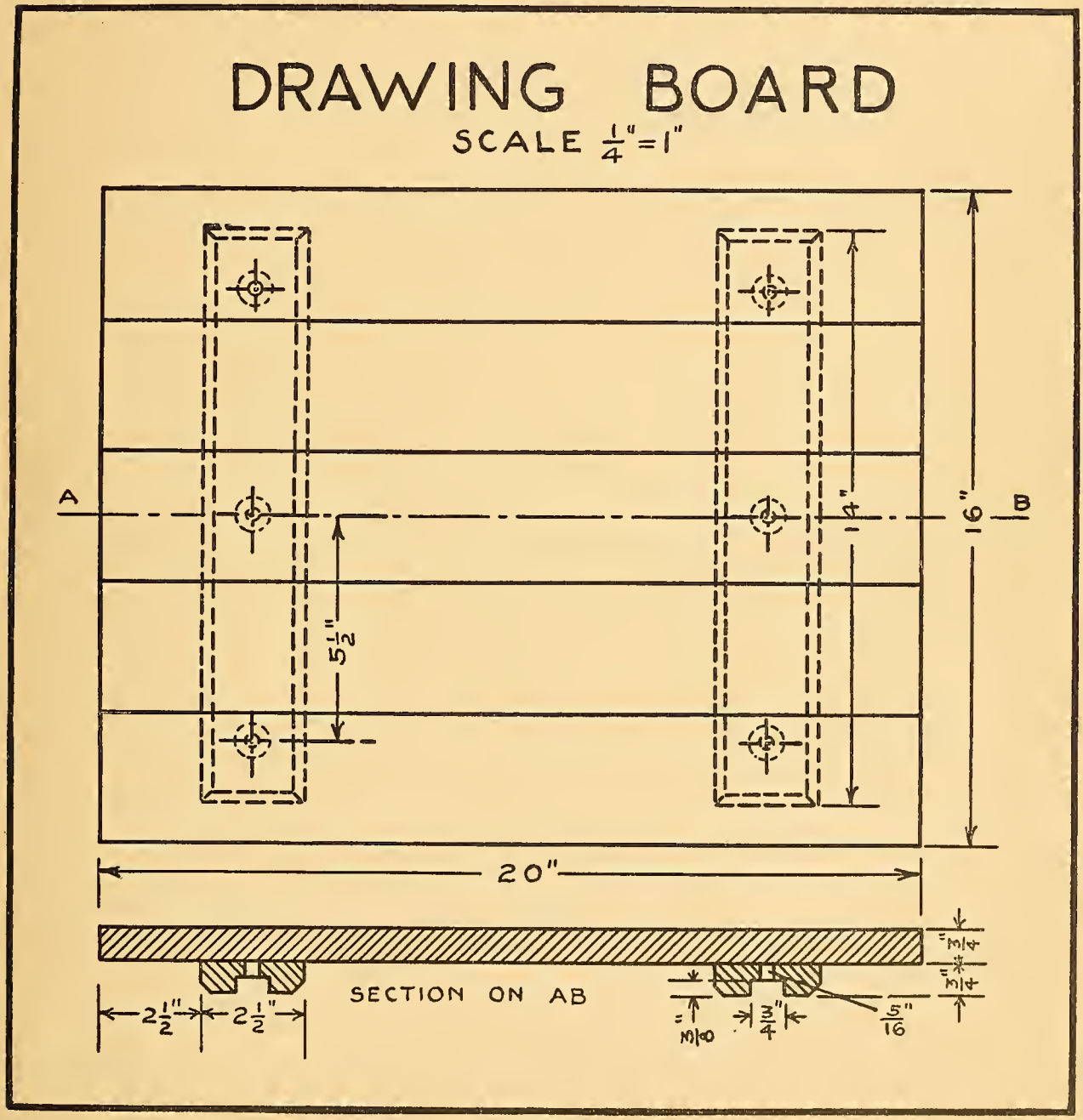
In using sandpaper it should be borne in mind that it is to be used only in the direction of the grain. The sandpaper should be wrapped around a block (preferably with a cork or rubber face). Very fine sandpaper (oo) is all that is needed.

# THE RENDERING OF A MECHANICAL PERSPECTIVE VIEW

The diagram on page 10 shows the method in common use for making perspective drawings from the plan and elevation. The line marked " picture plane " is drawn horizontally and the plan is so placed that one corner of it touches the picture plane. The plan may be turned at any angle with reference to the picture plane, according to the view desired. The station point may be selected by the observer, and marks the point from which the view is taken. To locate any point in the perspective plane from the plan, draw lines from the various points in the plan to the station point. When these lines intersect the picture plane they are projected downward at right angles to the picture plane. From the elevation the heights are projected horizontally to the line of heights, which is a line at right angles to the picture plane at B. The points marked V.P.L. and V.P.R. are, respectively, the vanishing point left and vanishing point right. The location of these points will vary with the view taken. To locate the vanishing point, draw lines from the station point parallel to the sides of the plan, as, in this case, parallel to B–C and A–B, extending them until they intersect the picture plane. The horizon line represents the level of the eye of the observer, and may be chosen at will. From the points where the lines parallel to A–B and B–C intersect the picture plane, project downward at an angle of 90 degrees from the picture plane until they intersect the horizon line. At


PLAN
A
B
C
PICTURE PLANE
HORIZON
V.P.L.
V.P.R.
PARALLEL TO AB
PARALLEL TO BC
GROUND LINE
ELEVATION
STATION POINT

these points of intersection the horizontal lines of the object will vanish to the right and left respectively. The various heights are now taken from the elevation and projected across to the line of heights. From the various points thus found on the line of heights converging lines are drawn to the vanishing points. By the aid of the vertical lines determining the various widths which are brought down from the plan, and the horizontal lines determining the heights which are brought over from the elevation the converging lines show the proper placing of each element of the object in perspective. As it is hardly within the scope of this book to give a fuller demonstration of perspective, it is thought best to include this diagram showing how perspective drawings of the various objects in the book may be rendered. It is recommended that the pupil familiarize himself with the matter of mechanical perspective by referring to some complete work upon the subject. Libraries are usually equipped with several good books. A very simple, concise presentation of the entire subject is found in a little book by Frank Forrest Frederick.



# DRAWING BOARD AND T-SQUARE

The drawing on the lower half of page 13 is the working drawing for a T-square, which will be used throughout the work in making the mechanical drawings. The working drawing for the drawing board is shown on page 11. Begin the construction of the drawing board by laying out and dressing up the stock according to the drawing. Stock should not be dressed to the exact length before gluing. Dress face side and both edges of each piece, being careful that they are square and straight. Use the jointer plane on these long edges and dress the edges in pairs until they exactly coincide, and mark each pair to go together. Glue the edges, being sure that the entire surface is covered with glue. If bubbles are left in the glue, or any part of the surface is left dry, the joint will probably open. Put the pieces in the clamps, protecting each edge from the clamp by a small block. They should remain in the clamp several hours, until the glue is thoroughly dry. When dry, dress this up as one piece to the required dimensions for the drawing board. The cleats should then be laid out, dressed up, and screwed against the back of the board, as shown in the drawing.

The T-square is very simple in construction but requires very accurate work, since the blade must be quite straight and must join the head at exactly a right angle. After dressing up each piece to dimensions, bore the holes in the blade to receive the screws but do not countersink them. Use blued, round-headed screws. The centre screw is started first and driven home. The blade is then squared with the head by means of the try-square and the other screws driven home.

# BENCH HOOK

On the upper part of page 13 is a working drawing of a bench hook. This is a rather simple exercise for beginning work, and is an article that is very often needed. Lay out and dress up the stock according to the drawing and assemble the parts, using flat-head bright screws.

Too much care cannot be exercised in dressing up the parts of the bench hook. In screwing together two pieces of wood, as in this case screwing on the cleats, it is best to bore holes through the cleat so the screw passes through readily, but not to bore holes in the other part. In this way the screw, passing readily through the cleat and boring its way into the other piece of stock, draws the two parts very tightly together. Before the screws are put in, the holes in the cleats should be countersunk. The positions of the screws are indicated on the drawing by small circles. It is not necessary to apply stain or other finish to such an object, although an oil finish will, to some extent, prevent its becoming soiled.

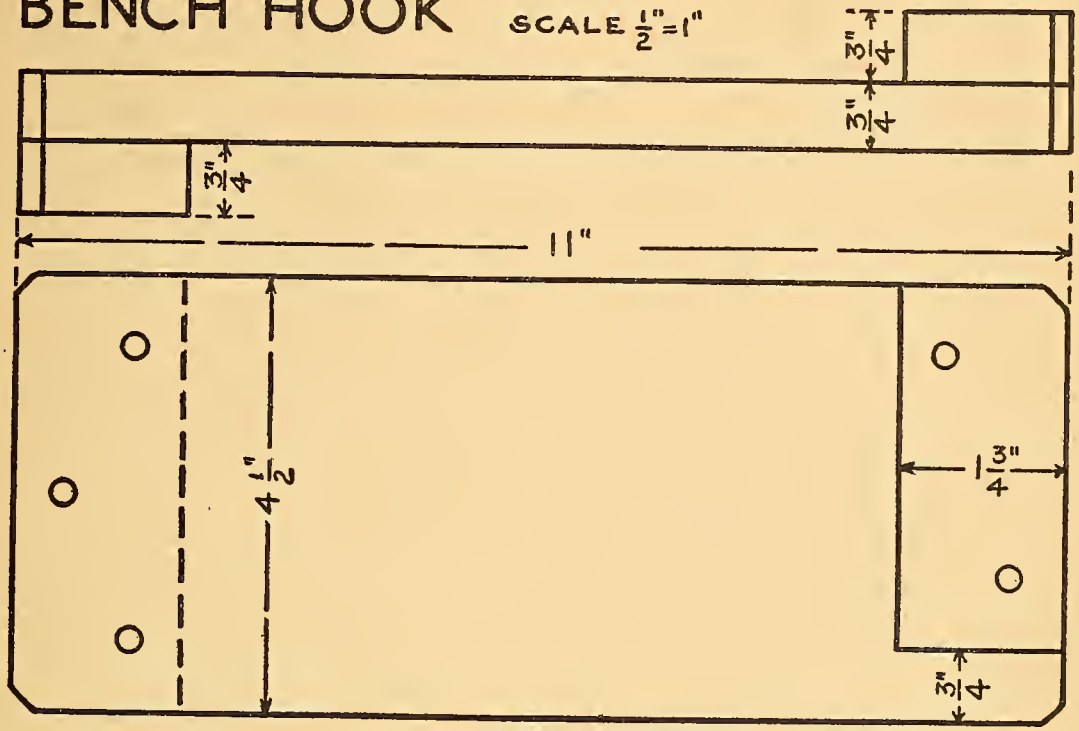
In using the bench hook the long cleat, the one going clear across, may be secured firmly in the vise and the stock to be sawed placed against the shorter cleat.

Figure 4 on page 5 shows the use of the bench hook in sawing small pieces of stock.

The bench hook should be kept near at hand and regarded as a part of the working equipment of the student.

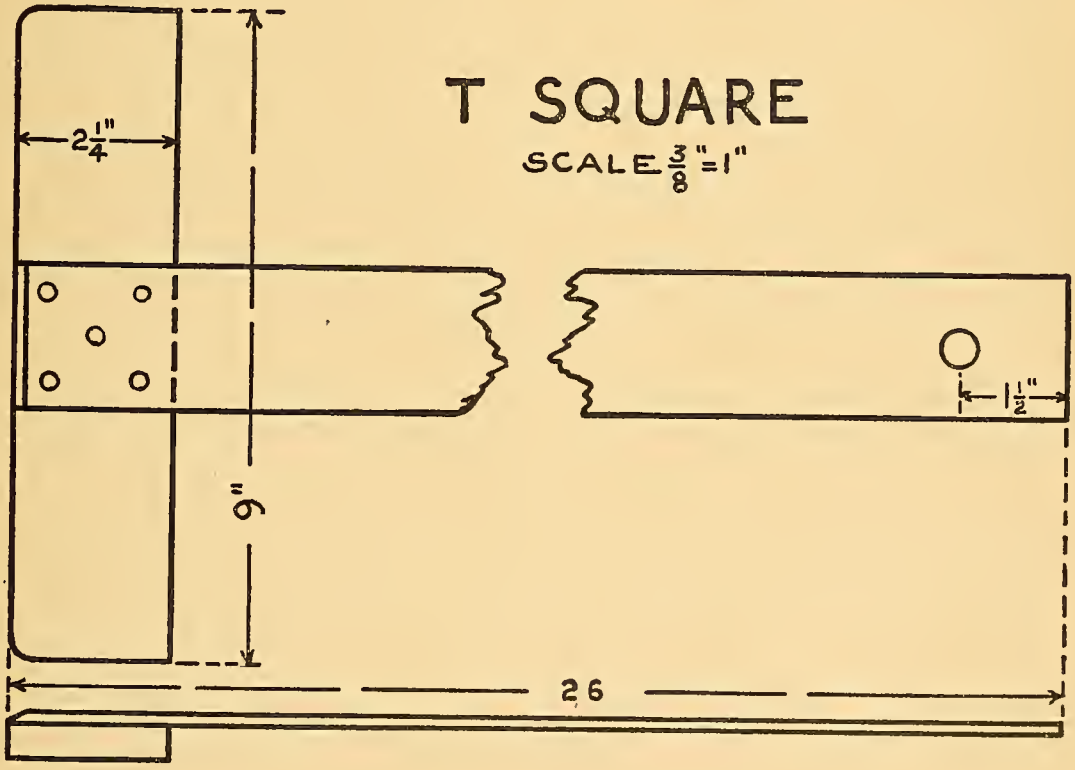
# BENCH HOOK

SCALE $\frac{1}{2}$"=1"



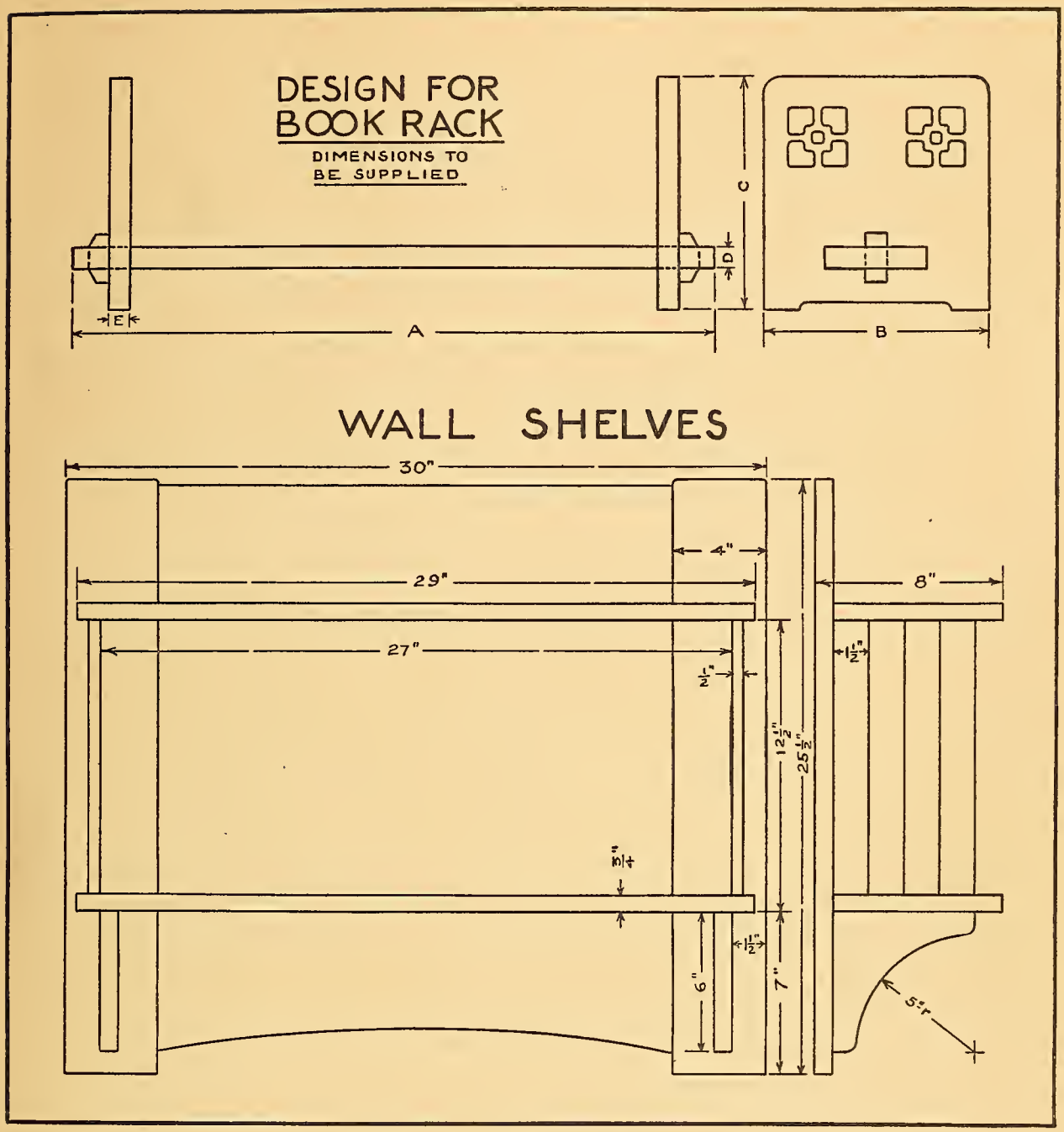

# T SQUARE

SCALE $\frac{3}{8}$"=1"



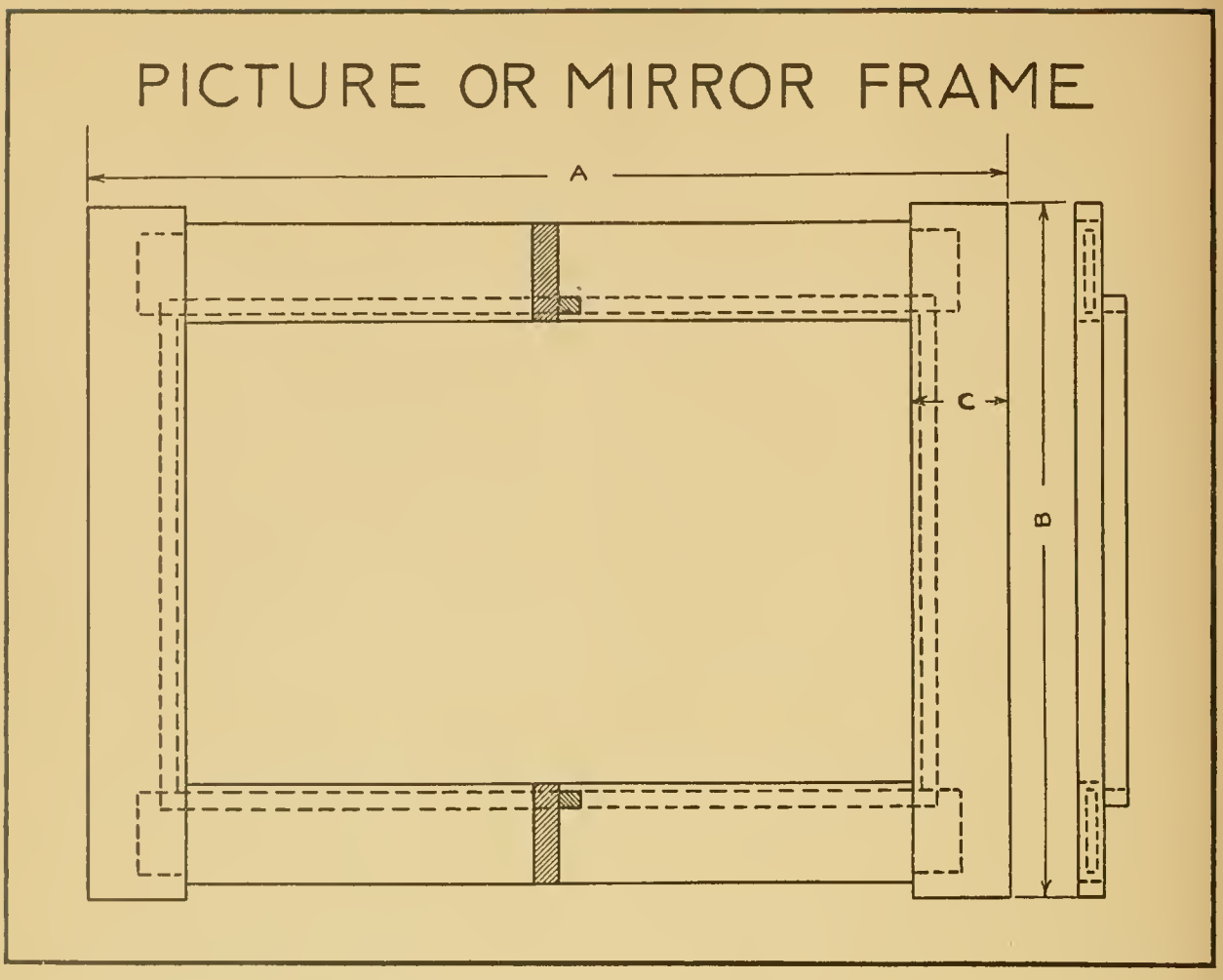
# BOOK RACK

A working drawing of a book rack is given on page 15, and on this page are four designs for the decoration of the end of the book rack. Decide upon the shape of the end, and the general design of the object. Then lay out and dress up all stock, according to your drawing. After the various parts are finished to dimensions the design which you have decided upon may be outlined upon the ends of the book rack by means of the veining tool, and the spaces colored with oil stain or water color. Any suitable stain or finish may be applied to the entire book rack. (See page 9.)




# WALL SHELVES

The lower drawing on this page is a working drawing for a very useful piece of wall furniture, and offers a very interesting problem in wood construction. The drawing, as it is given, involves a good many pieces of material, and, if thought best by the one constructing it, it may be simplified somewhat. The vertical pieces connecting the two shelves may be replaced by one piece of the same width as the bracket below. The whole project may be screwed together, instead of mortised and tenoned. The drawing, as it is given, plans for the main part of the back to be rabbeted into the upright end pieces. The entire piece may be hung from the molding of the room by means of small chains. Holes should be bored through the upper ends of the upright pieces to receive the chain.

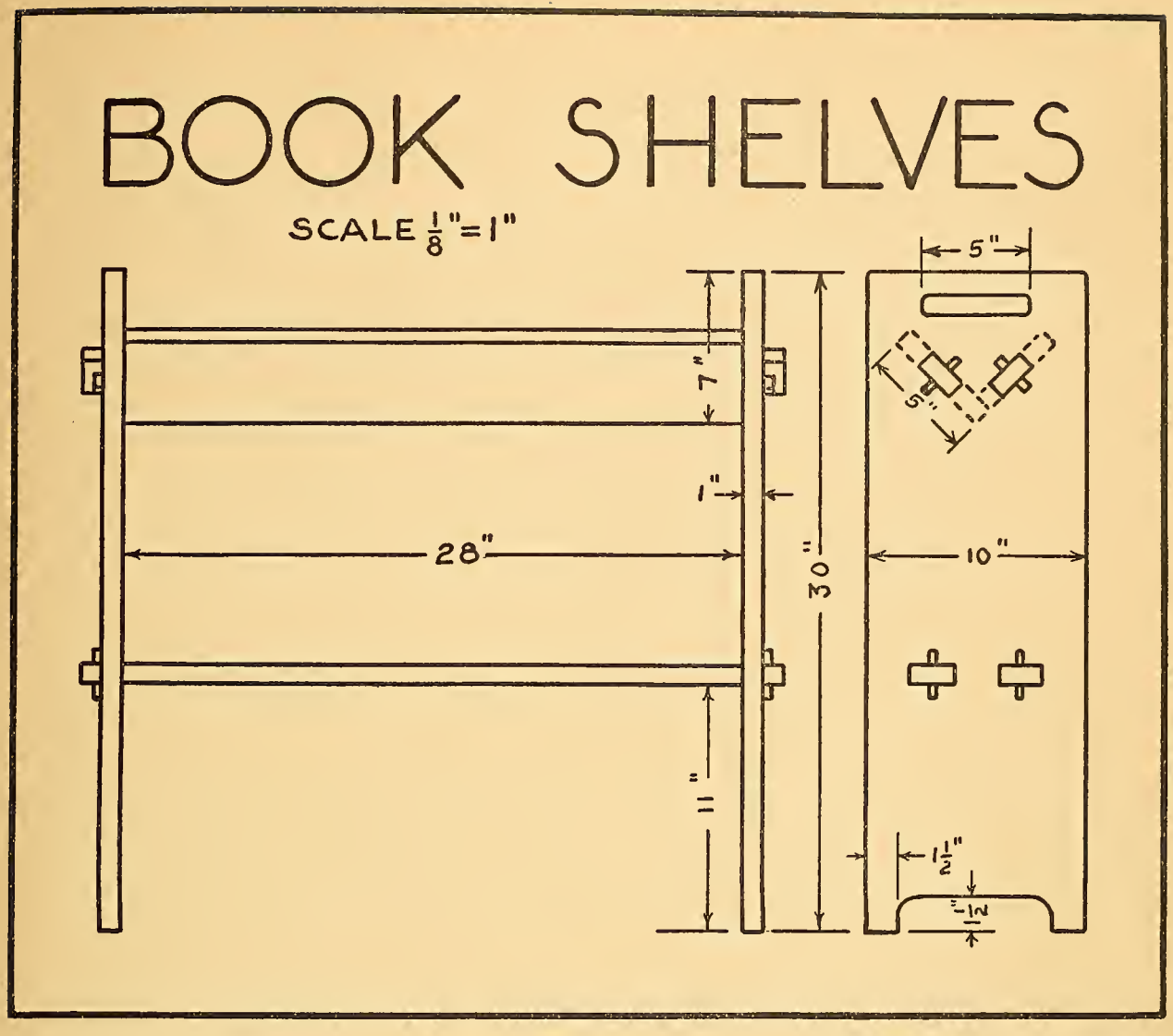



# PICTURE FRAME

The above drawing shows a very excellent method of making frames for pictures or for mirrors. The ordinary frame is usually mitred at the corners, and even when the joints are well made and carefully glued they are likely to open. The mortise and tenon structure shown in this drawing not only holds better, but, in the author's opinion, has a better structural appearance than the mitred corner. It not only has solidity but the appearance of solidity. The end pieces may be allowed to extend as in the drawing or not, at the will of the worker. The back may be rabbeted to receive the picture, or thin strips of wood may be screwed against the back, as shown in the drawing. The dimensions are to be supplied to fit the purpose for which the frame is intended.

# A FOLDING SCREEN

In the drawing for a folding screen, on page 21, the scale of 3/32″ = 1″ has been used. If the dimensions are not satisfactory, rearrange them according to your needs and make a drawing to scale. From your drawing make a stock list and proceed to lay out, dress and finish, as in the other exercises. Mortise and tenon structure is to be used in the screen, but the joints have not been shown in the drawing. Doweled butt joints may be used in place of the mortise and tenon. The large panels in the lower part of the screen may be of linen, canvas, leather or other suitable material, on stretchers. A stretcher is merely a wooden frame made to fit into the place, and the material is drawn over it from either side. The stretchers may be held in place by dowels. Any stain or finish in harmony with the general surroundings will be suitable.




## BOOK SHELVES

Study the drawing of an arrangement of book shelves on this page. Decide upon the dimensions desired, if those given are not satisfactory. The drawing on the page is made up to the scale of 1/8″ = 1″. Make a stock list, giving the number of parts and their dimensions. Lay out, cut and dress up stock. Lay out all the mortise and tenon joints before beginning to cut them out. Confer with your teacher about the best method of procedure. When all parts are finished you are ready for assembling. The keyed mortise and tenon structure renders this piece of furniture capable of being taken apart at will. If the joints are carefully fitted it will be very firm and solid. Stain the wood to match other articles in the room where it is to be used and apply a wax finish.

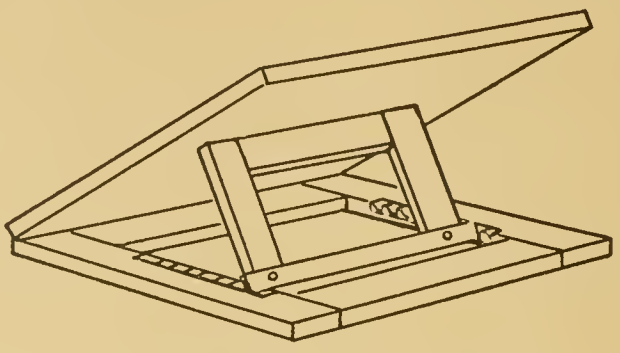
## AN ADJUSTABLE DRAWING BOARD

It is often desirable to have a drawing board which will adjust to various angles, especially where freehand drawing is to be done on a desk that has a low and flat top. In such a difficulty a very simple drawing board like the one given on page 18 will lessen the difficulties. It consists of a drawing board which is hinged to a base and held in place by a support hinged to the board, and

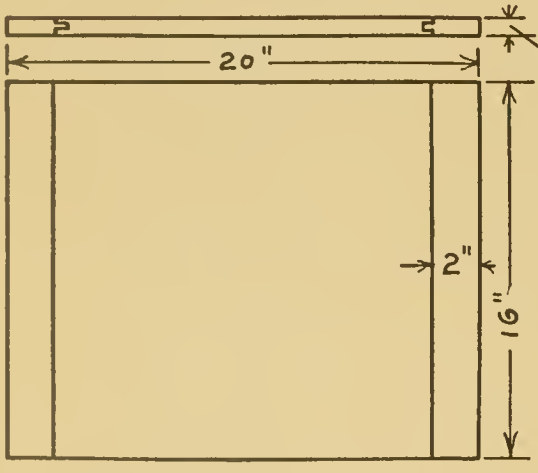
# ADJUSTABLE DRAWING BOARD

TO BE MADE OF $\frac{7}{8}$" WHITE PINE

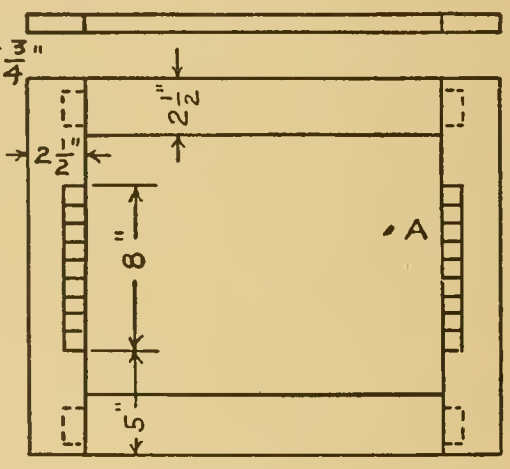
SCALE $\frac{1}{8}$"=1"



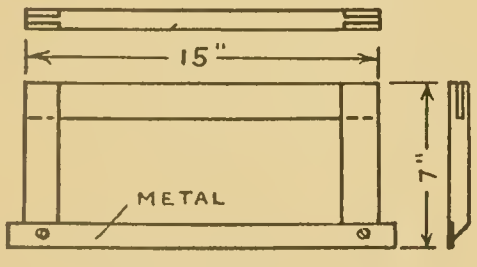
PERSPECTIVE - REAR



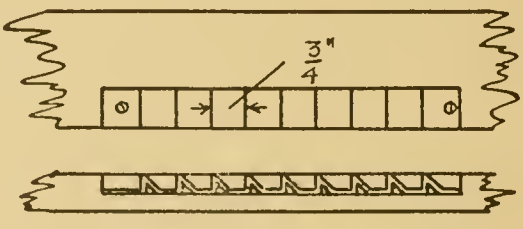

DRAWING BOARD




BASE




SUPPORT




DETAIL AT A

which runs in a metal rachet in the base. The base is made of four pieces, mortise and tenon, as shown in the drawing. The support is of three pieces of wood and a strip of metal which works in the rachet. The metal facing of the rachet may be readily constructed from Venetian iron bent as shown in the detailed drawing and screwed to the base at either end. If these dimensions are not satisfactory, or if you have a drawing board which you wish to mount in this way choose dimensions to suit. White pine is excellent material for this purpose, and it may be given an oil finish, or stained, at the discretion of the instructor.

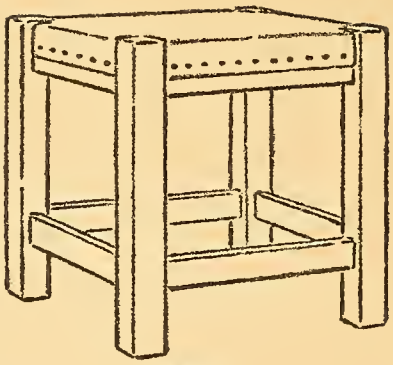


Fig. 11

# PLANNING AND MAKING A STOOL

Every problem in structural design calls for a study of size, shape and proportions dependent upon the use of the completed object. The stool should be strong but not clumsy. Let us build the frame of small pieces fastened securely at the ends by means of joints. The most satisfactory joint for this purpose is the mortise and tenon. (See page 8.) By its use we can join securely pieces placed at right angles with each other. The problem of any side of the stool resolves itself into an arrangement of vertical pieces (stiles) and horizontal pieces (rails). Make freehand sketches of several arrangements of different proportions and select the best. Make a drawing to scale from this sketch. Lay out and dress up all pieces to the dimensions given in your drawing, except length. Next lay out the mortises and tenons. When ready for gluing one side should be assembled and glued up as a completed whole. The opposite side should be treated likewise. After the glue upon these two sides has thoroughly set the remaining rails, forming the other two sides, may be inserted and the stool again put in clamps to dry. It is then ready for finishing.

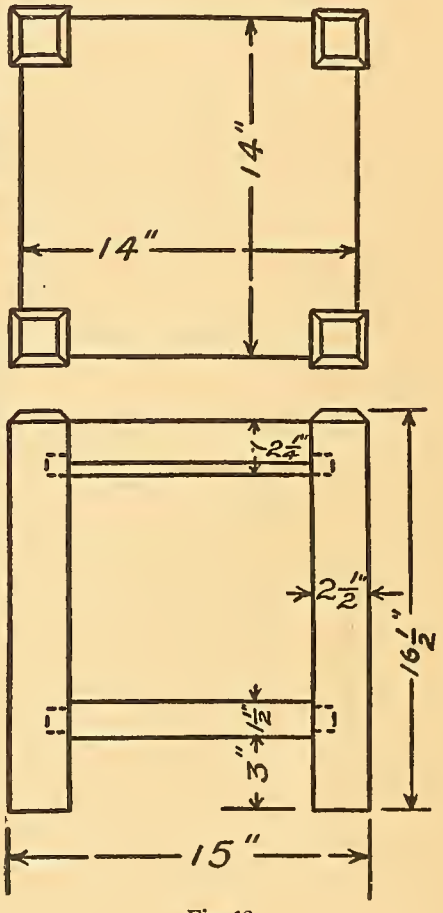



Fig. 12

# PLANT STAND

On page 20 is the working drawing for a plant stand. This is somewhat more difficult than the stool on page 19, but somewhat similar in construction. Proceed in the same general way, cutting out and dressing up all parts before assembling. Assemble and finish as in the other exercises.

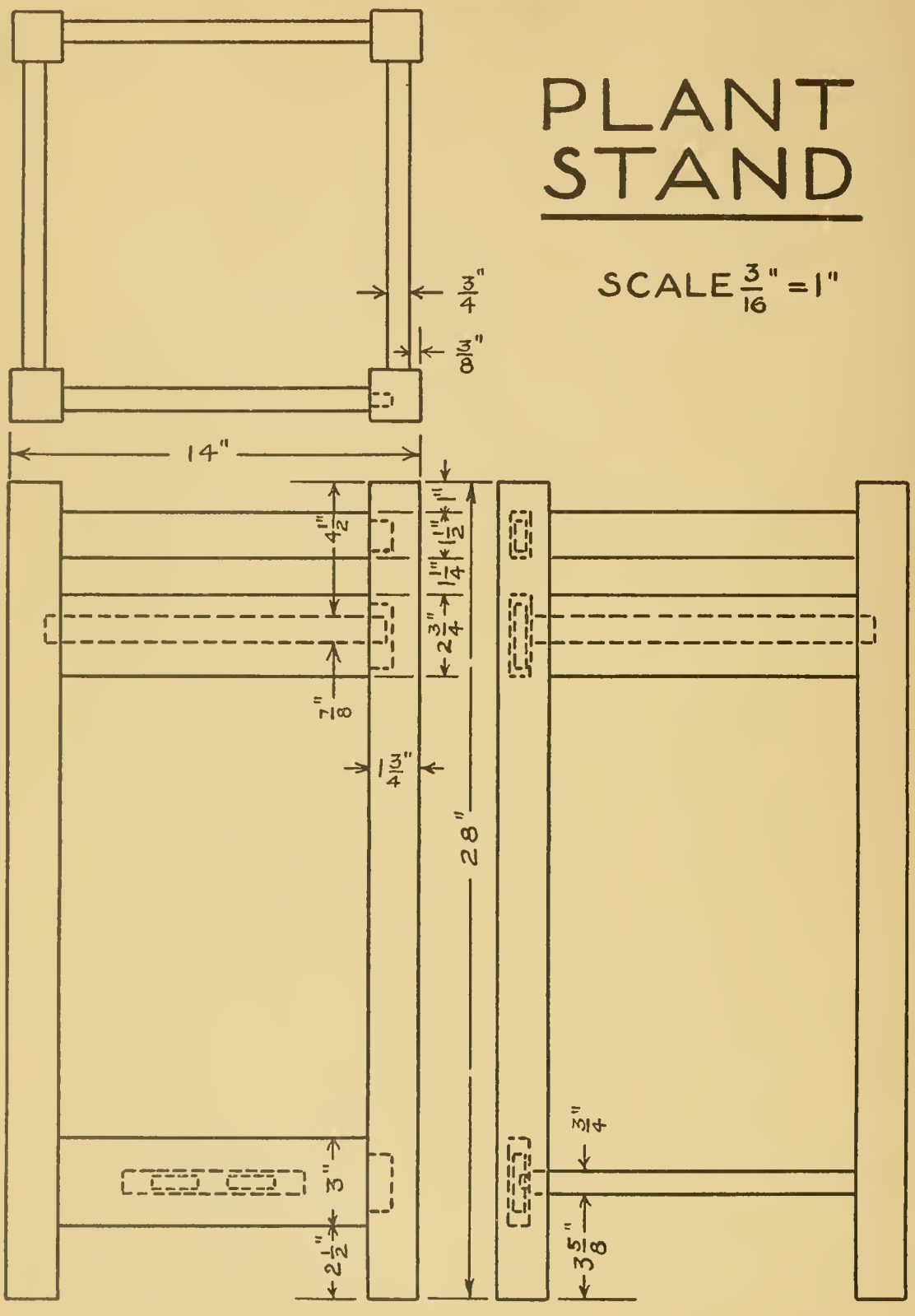
# TABLES

The drawings on pages 22 and 23 show tables for various purposes, the small round table on page 22 being the easiest to construct. As the working drawings for these various tables are very complete, it is deemed hardly necessary to give very definite instructions concerning the making of each piece. The same method of procedure should be followed as in the other projects, and the student should advise with his instructor before deciding upon the dimensions and design of any of the projects. The style of construction, the various joints needed, and the kind of stain and finish should all be carefully considered before beginning the actual work of making.

A working drawing showing the structure of a drawer suitable for the tables on page 23 is given on the lower part of page 24. For the various joints involved see pages 7 and 8.

# PLANT STAND

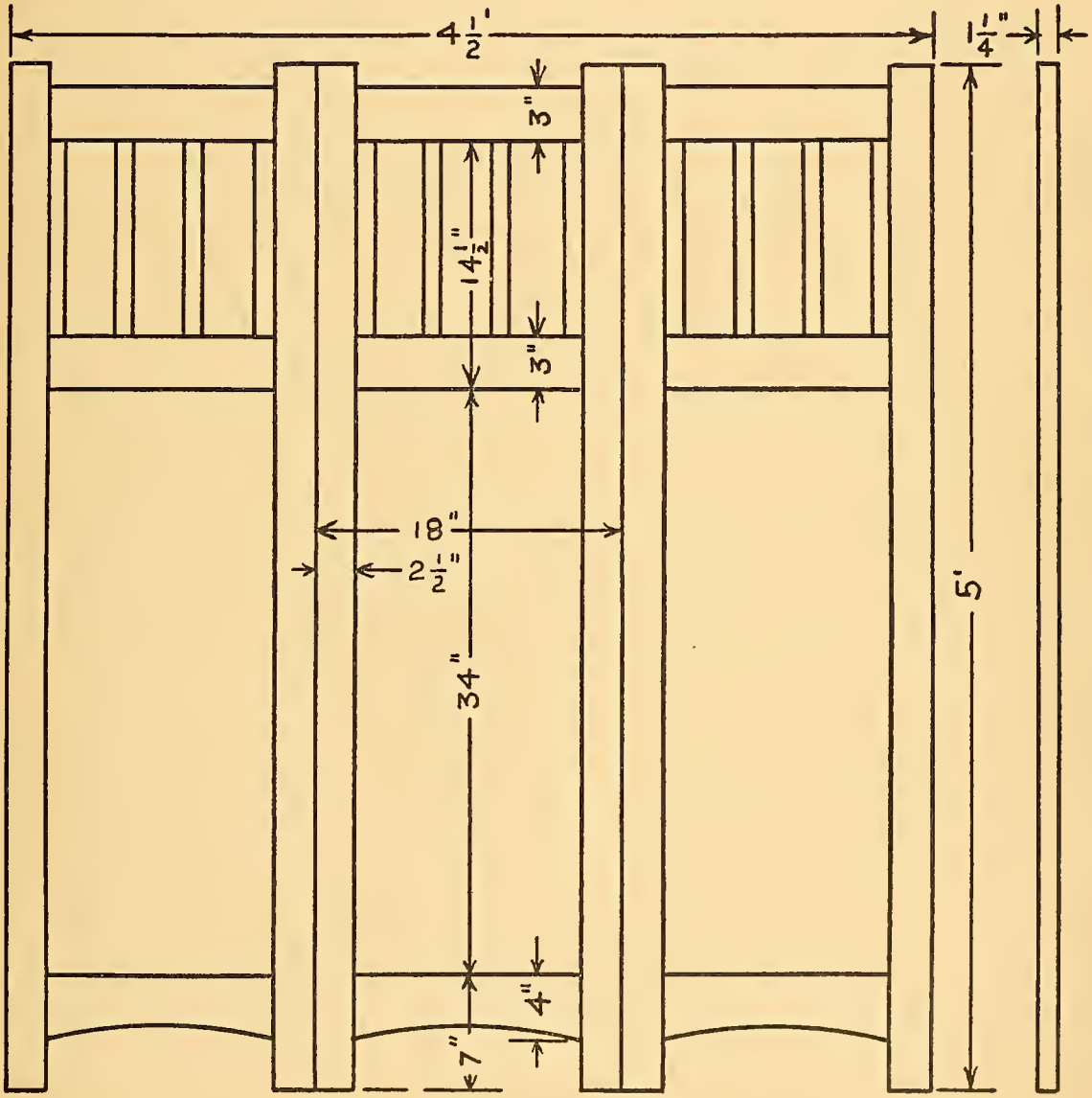
SCALE $\frac{3}{16}$" = 1"



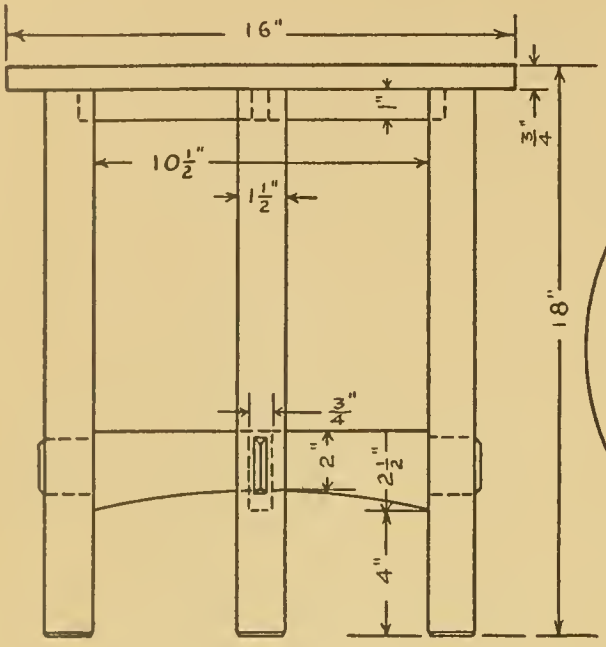
# DESIGN FOR A THREE SECTION FOLDING SCREEN OF WHITE OAK

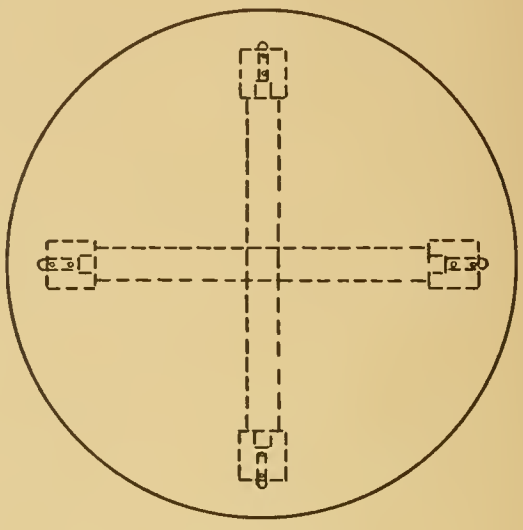
PANELS OF CANVAS OR LINEN ON STRETCHERS

SCALE $\frac{3}{32}$" = 1"



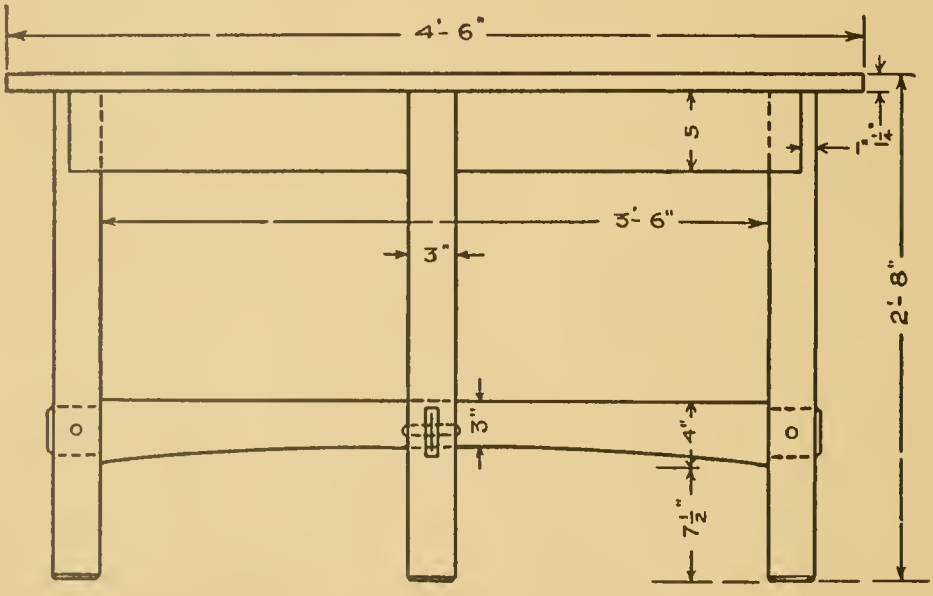
# SMALL ROUND TOP TABLE



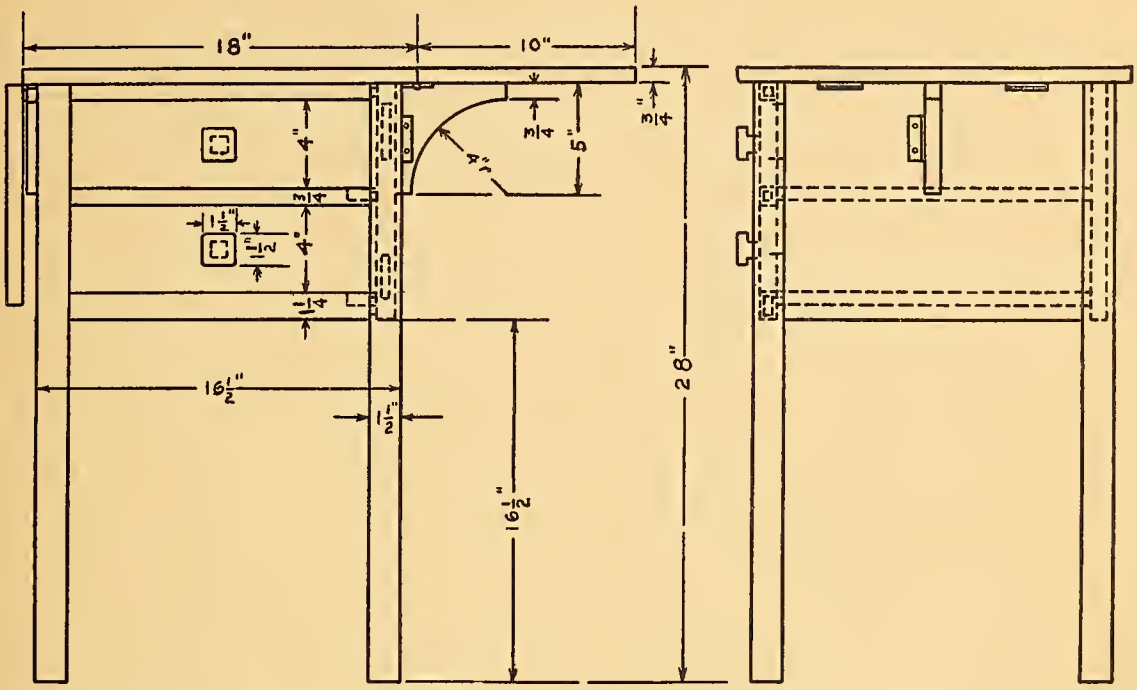



TOP VIEW

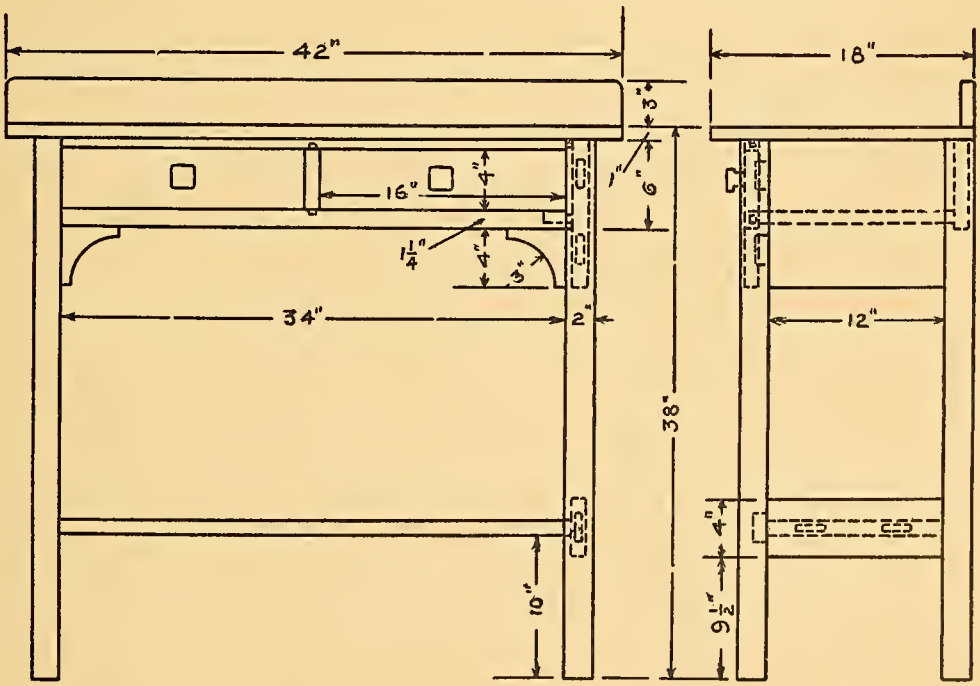
# DINING TABLE

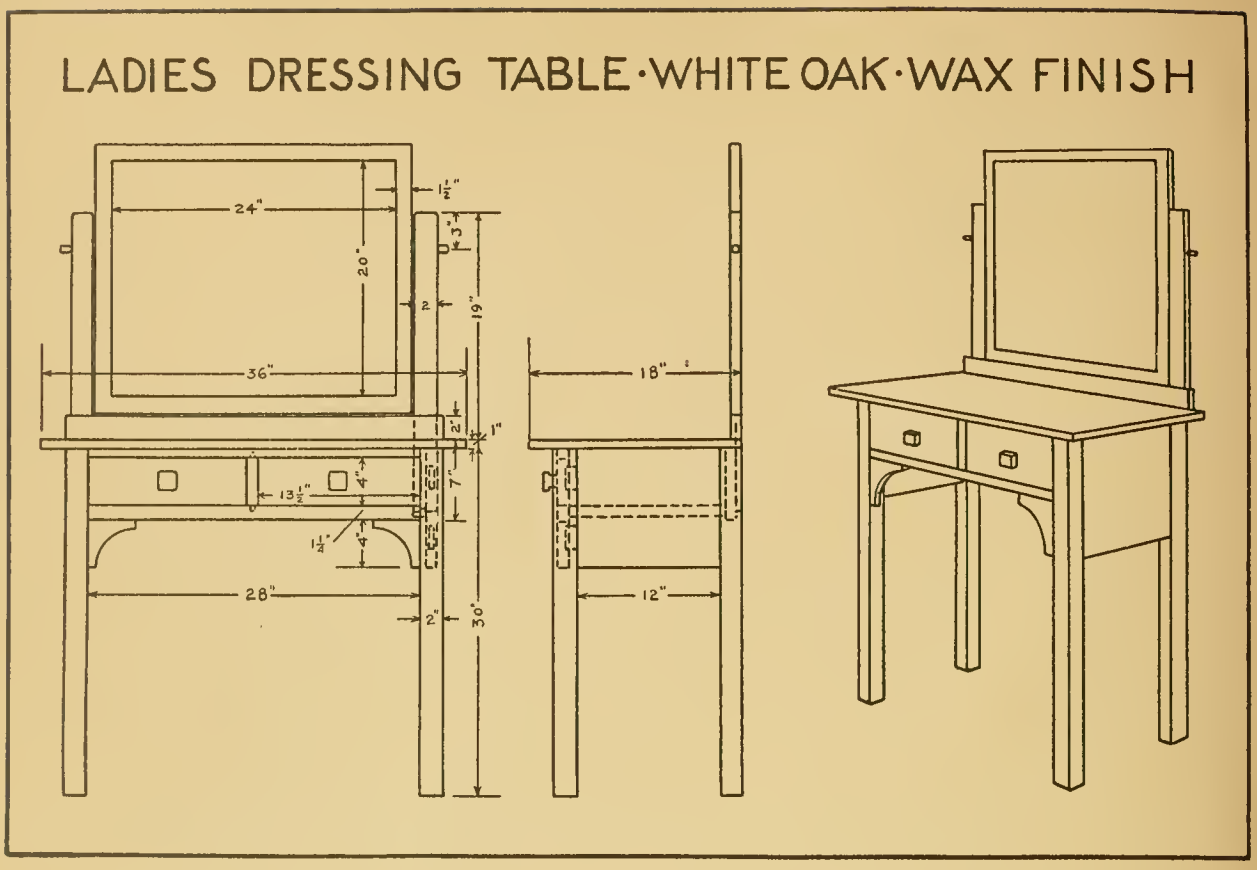


# SEWING TABLE




# SERVING TABLE





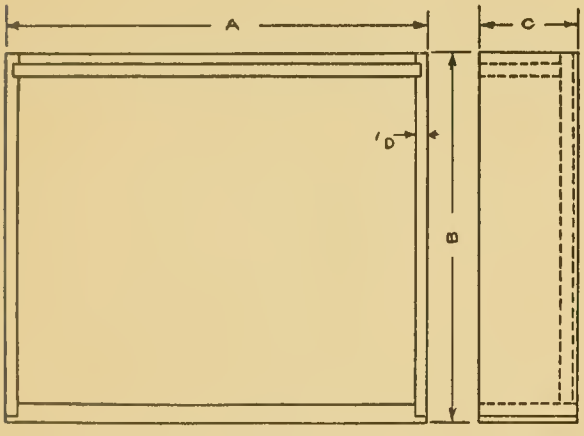




Fig. 13

## LADIES' DRESSING TABLE

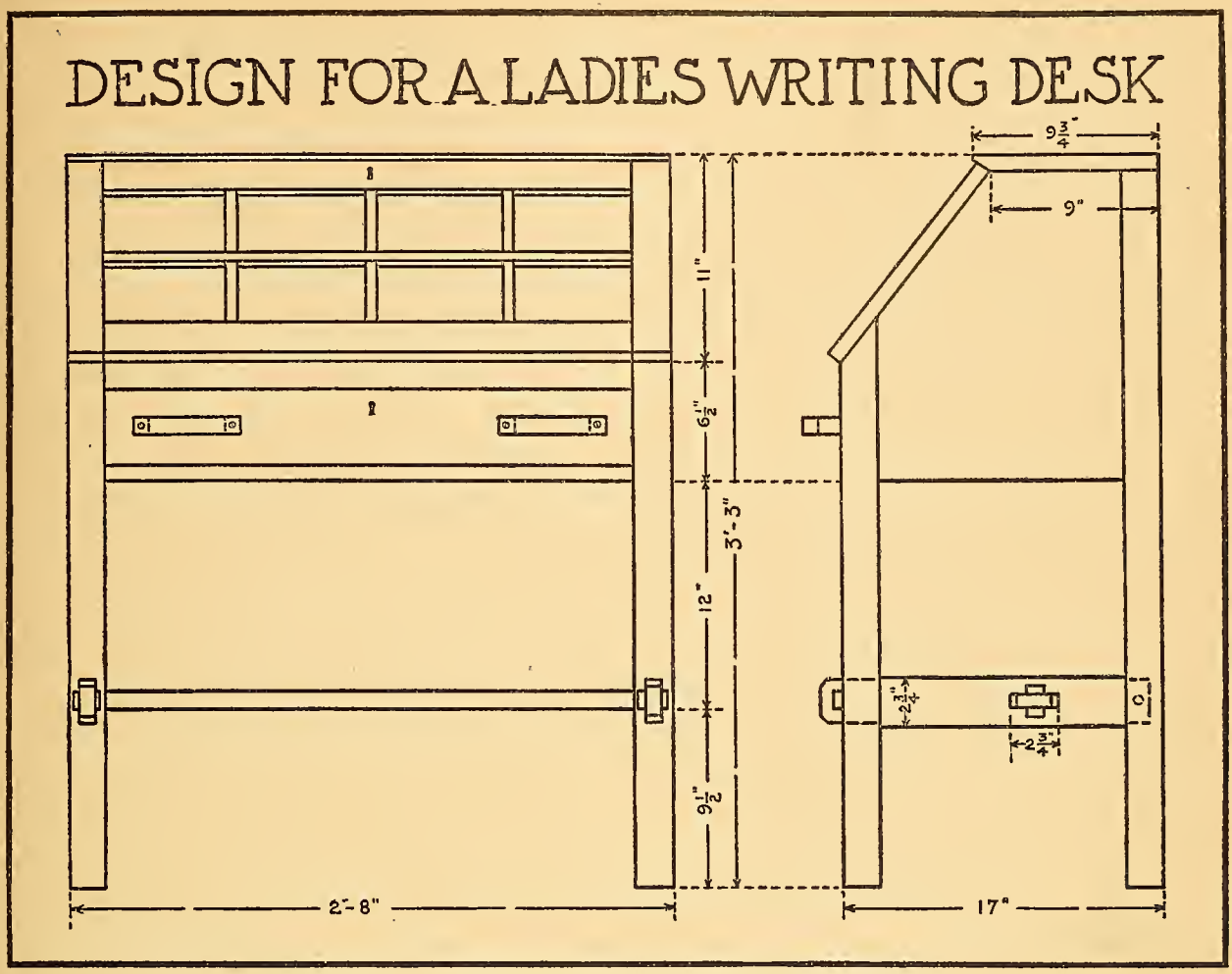
The drawings at the top of this page show two working views of the dressing table and a perspective sketch showing its appearance when completed. As in the case of all the projects given in this book, the dimensions need not be followed absolutely, but they have been thought out with much care and show excellent proportions. Unless there is some good reason for changing them, it would be well for the student to follow at least the general proportions very carefully.

## A HALL SEAT

The working drawing appearing at the top of page 26 shows the structure of a hall seat. This is rather a large project, and is suitable for a class exercise. No single part is very difficult, yet it takes very great care in all parts to have the entire piece satisfactory when it is assembled. If it is taken up as a class project each student should be very particular to have his part absolutely accurate.

## LIBRARY TABLE

The working drawing of a library table appears at the lower part of page 26. The authors have had similar tables made completely by eighth grade pupils working upon them as class projects. However, unless the class is fairly well advanced, and has had a good deal of preliminary work, it would be useless to attempt so difficult a project. It is excellent work for high school classes, and the table, when completed, makes a fine addition to the school library equipment.




# A LADIES' WRITING DESK

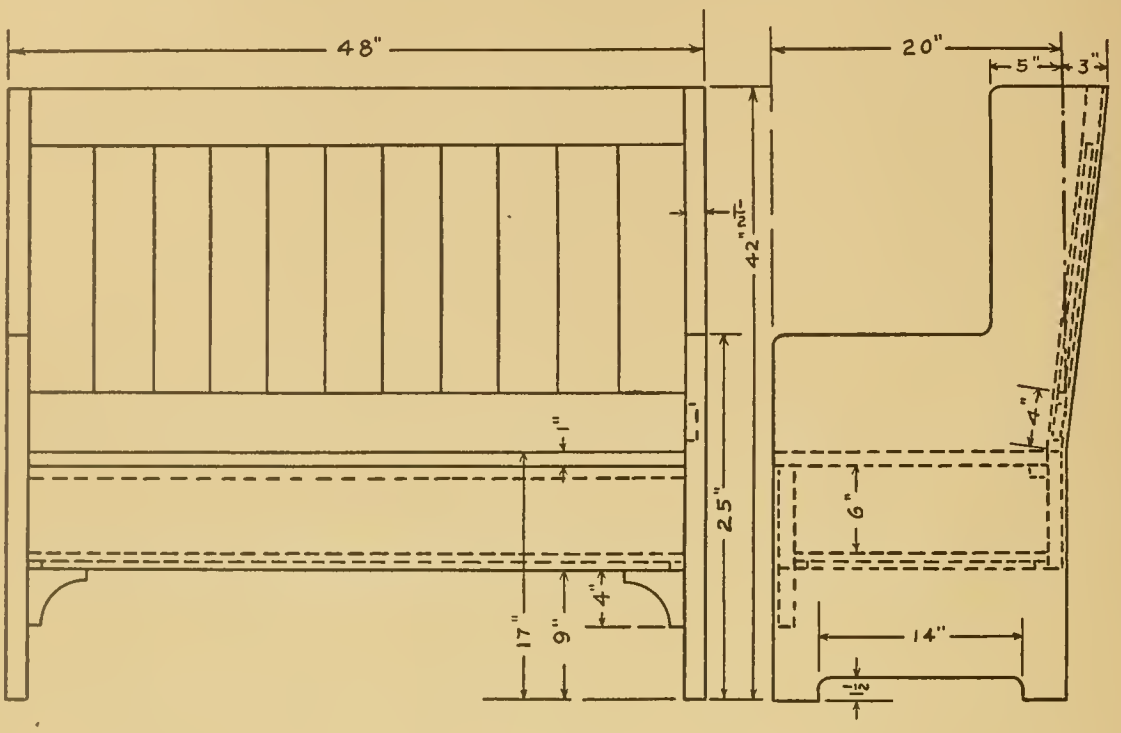
The accompanying working drawing of a ladies' writing desk is complete enough to work from in constructing the desk. This is rather a difficult problem in cabinet making and should not be attempted until a good deal of preliminary work has been done. Study the various parts carefully, noting the dimensions, and decide upon the means of fastening together the various parts. For the most part this has not been shown in the drawing, and was purposely omitted, to give the student an opportunity to decide upon the best means of construction.

The student should advise with his instructor concerning the various structural problems involved, and the kinds of joints, methods of cutting them, methods of staining and finishing should all be thoroughly discussed before the work of cutting out the stock is begun. The dimensions need not be those given on the drawing, but may be suited to the personal needs of the student. This writing desk may be simplified considerably if the student has not done sufficient preliminary work.

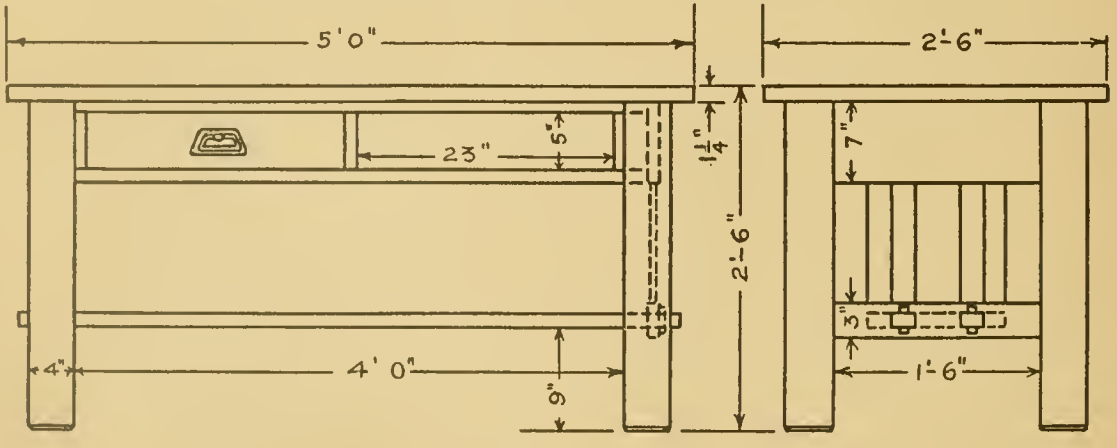
The paneling on the lid may be reduced to a single panel. The student should study the drawing carefully, and it would be well for him to go, with note-book in hand, to a furniture store and note the various kinds of writing desks to see if there are changes which he can profitably make in the model. After all these things have been decided upon, and the project has been approved by the instructor, a careful drawing should be made, a stock list prepared, and the student is then ready to begin the actual work of making the desk.

# HALL SEAT

THE SEAT IS HINGED AND ACTS AS A LID FOR BOX UNDER THE SEAT- 6" X 46"




# ·LIBRARY·TABLE·



# METAL WORK

## Processes

### I. SAWING

The metal saw and the method of using it are pictured in Fig. 14. A small piece of wood with a notch in it is securely fastened to the bench and the metal held tightly against this board. If the metal is allowed to move the saw is very likely to be broken. The saw should work very freely and should not be hurried. Care should be taken to see that the cut is vertical through the metal. Follow the outline that has been marked as nearly as possible, keeping just outside of it. After the piece has been sawed out it is ready for finishing.

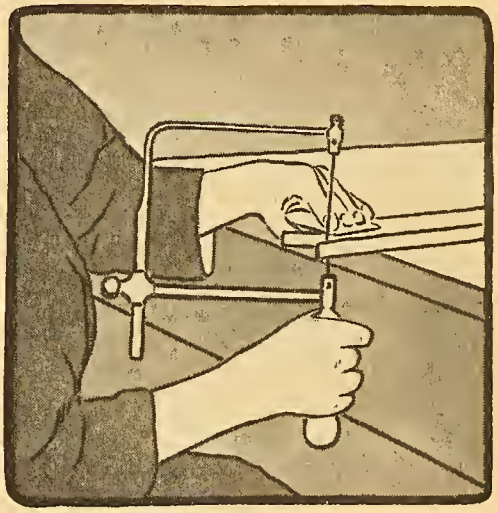


Fig. 14

### II. FILING

Small files, known as needle files, are most useful in finishing small parts of metal work. A larger file may be used to straighten up the outer edges, but very fine files should be used for finishing. The corners and edges of the metal should be slightly rounded. After the piece is filed as nearly as possible to the proper size and shape a piece of emery cloth should be used to remove all roughness or irregularity in the surface.

### III. PIERCING

Where parts of metal are to be cut out it will be necessary to first drill holes through each of the parts to be removed. (See Fig. 15.) Detach one edge of the saw blade from the frame and insert it in the hole in the metal. Attach it again to the saw frame and proceed to saw out the part required. Finish as before.

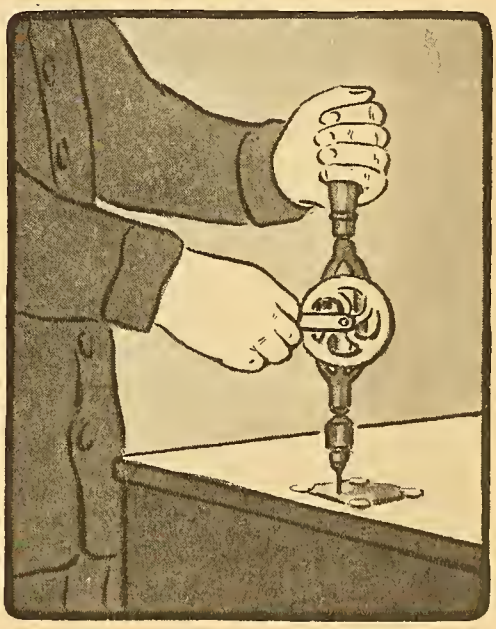


Fig. 15

### IV. ANNEALING

It will be found that after working for a while with copper or brass the metal becomes quite hard, and is difficult to work. It should then be annealed, or softened, which is done by heating it to a cherry red over a gas plate, or other flame, and immersing it in water. As often as the metal becomes hardened it should be annealed to facilitate the work. In finishing a piece of work, however, care should be taken to leave it as hard as possible.

### V. SOLDERING

When it is desired to solder together two pieces of metal, they should first be cleaned carefully in what is commonly known as pickle (a solution of one part sulphuric acid and twenty parts water). This serves to clean the surface. Both parts to be soldered should be carefully cleaned,

placed together, and bound solidly with thin binding wire. The flux used for copper, brass or silver is borax. Rub a piece of borax in a little water in a saucer until enough is precipitated to color the water slightly. Cut up silver solder in small parts, about 1/16 of an inch square, and drop them into the flux. Cover the parts to be soldered with this flux and using a small brush pick up the particles of solder and lay them around the joint. By means of the blow pipe apply a blue flame to the metal, very slowly at first to prevent the solder from flying. (See Fig. 16.) Continue the flame until the metals fuse. Remove the binding wire and drop the metal in water to cool. It may then be finished by the use of needle files, emery cloth, and a small stone known as the tam o' shanter hone, which will be found very useful in working into the various parts. Where more than one job of soldering is required on the same article, the first one should be entirely covered with a paste formed of yellow ochre and water before beginning the second heat; otherwise it may become unsoldered.

Fig. 16

## VI. PUNCTURING

A very simple method of treating backgrounds in thin metal work is known as puncturing. The design is laid out carefully in pencil and the background is punctured by a small tool like an awl, struck with a light hammer. This is a simple and fairly satisfactory way of treating backgrounds in such objects as lamp shades, where it is desired that the light should shine through.

## VII. REPOUSSÉ

The process of repoussé is that of raising in relief a certain part of the design. The design is drawn upon the reverse side of the metal. A bath of pitch and tallow is then warmed slightly and the metal pressed into the pitch, with the drawing up. The parts intended to be in relief in the finished article are then hammered down into the pitch. This may be done by tools of any shape that will accomplish the purpose. Students can make the necessary tools of large wire nails, filing them to the desired shape. After the process is carried as far as possible in this manner the pitch is again warmed until the metal is released. It can be cleaned readily with turpentine or by heating. It should then be replaced, face side up, and gone over with small tools, rectifying all the slight errors and completing the work generally.

## VIII. ETCHING

Before etching a design upon metal, the metal should be cleaned carefully with pumice stone and water, or with alcohol, or pickle, and the design carefully drawn upon the metal. The parts that are not to be etched should be covered with a thick coating of asphaltum, which will resist the acid. It should then be allowed to dry for several hours. If put into the acid too soon the asphaltum may be removed and the work ruined. After the asphaltum is thoroughly dry and every part protected, immerse in the following solution and allow to remain until etched to a sufficient depth:

3 parts water, 1 part nitric acid, 1 part sulphuric acid.

The article may then be removed from the acid and washed in water to stop the action of the acid. If care has been given to the putting on of the asphaltum and allowing it to dry, the design should be clearly cut. The asphaltum may then be removed with turpentine.

## IX. ENAMELING

The process of enameling as practiced by jewelers and silver-smiths generally is not a practical public school problem, but for all the work given in this book where enameling is desired the design may be etched as described above, and the parts which have been etched may be filled with bath-tub enamel which has been previously tinted with artists' oil colors to any desired hue. It should be allowed to dry for several hours and the surface pumiced smooth and level with the surface of the metal. The entire object may then be lacquered if desired.

## X. OXIDIZING AND COLORING

A very interesting way of treating metal is to apply to it one of the following solutions, which will color the metal more or less permanently. The high lights may be rubbed off after the solution is dry and the lower parts and depressions may be left. The following solutions are suitable for coloring brass or copper:

### SOLUTIONS FOR COPPER, BRASS, AND SILVER

To oxidize silver, paint it with a solution of one part of potassium sulphide to four parts of water. Let dry and rub off high lights.

For silver, copper or brass, a solution of 1/4 oz. chloride of antimony in 4 oz. of chloride of iron will be found very satisfactory.

Another one for the same metals is 1/2 lb. oxide of iron to which is added one oz. of platinum.

To color copper green: 1 oz. sal ammoniac, 3 oz. cream tartar, 6 oz. common salt, 12 oz. hot water, 2 oz. copper nitrate. Sprinkle the solution over the article. Then wash in cold water and dry over a Bunsen burner.

Following are two tables showing liquids for coloring brass or copper by simple immersion. (From "The Metal Workers' Handy Book," by William T. Brantt. Used by permission of the publishers, Henry Carey Baird & Co.)

FOR BRASS

| Water | Nitrate of Iron | Perchloride of Iron | Permuriate of Iron | Tersulphide of Arsenic | Muriate of Arsenic | Potash Solution of Sulphur | Pearl Ash Solution | Sulphocyanide of Potassium | Hyposulphite of Soda | Nitric Acid | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pt. | dr. | dr. | pt. | gr. | oz. | dr. | dr. | dr. | dr. | dr. | |
| 1 | 5 | | | | | | | | | | Brown and every shade to black |
| 1 | | 5 | | | | | | | | | " " " " " " |
| 1 | 16 | | | | | | | | 16 | | Brown and every shade to red |
| 1 | | | | | | | | | 16 | 1 | " " " " " " |
| 1 | | | | 30 | | | 6 | | | | Yellow to red |
| 1 | | | | | | 1 | | | | | Orange |
| 2 | | | 1 | | | | | | | | Olive green |
| 1 | | 5 | | | | | | 2 | | | Slate |
| 1 | | | | | | | | | 20 | | Blue |
| 1 | | | | | 1 | | | | | | Steel-gray |
| 1 | | | 2 | | 10 | | | | | | Black |

Fig. 17

| Water | Nitrate of Iron | Sulphate of Copper | Sulphide of Antimony | Sulphur | Pearl Ash | Sulphocyanide of Potassium | Hyposulphite of Soda | Hydrochloric Acid | |
|---|---|---|---|---|---|---|---|---|---|
| pt. | dr. | oz. | dr. | dr. | oz. | dr. | oz. | dr. | |
| 1 | 5 | | | | | | | | Brown and every shade to black |
| 1 | 5 | | | | | 2 | | | Dark brown-drab |
| 1 | | 1 | | | | | 1 | 2 | " " " |
| 1 | | | 2 | | 1 | | | | Bright red |
| 1 | | | | 1 | 1 | | | | Red and every shade to black |

Fig. 18

## XI. RAISING

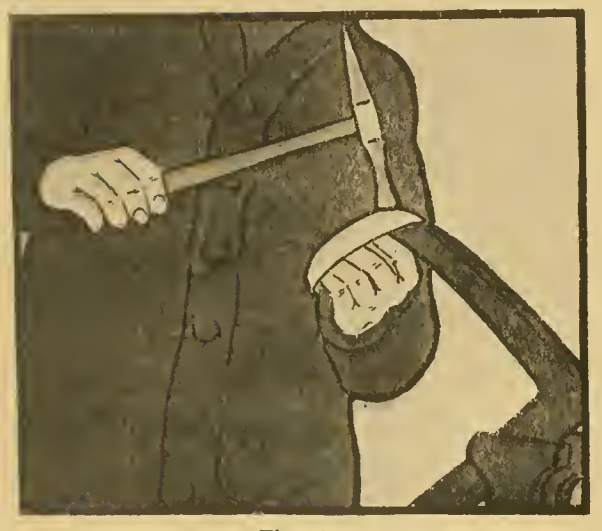


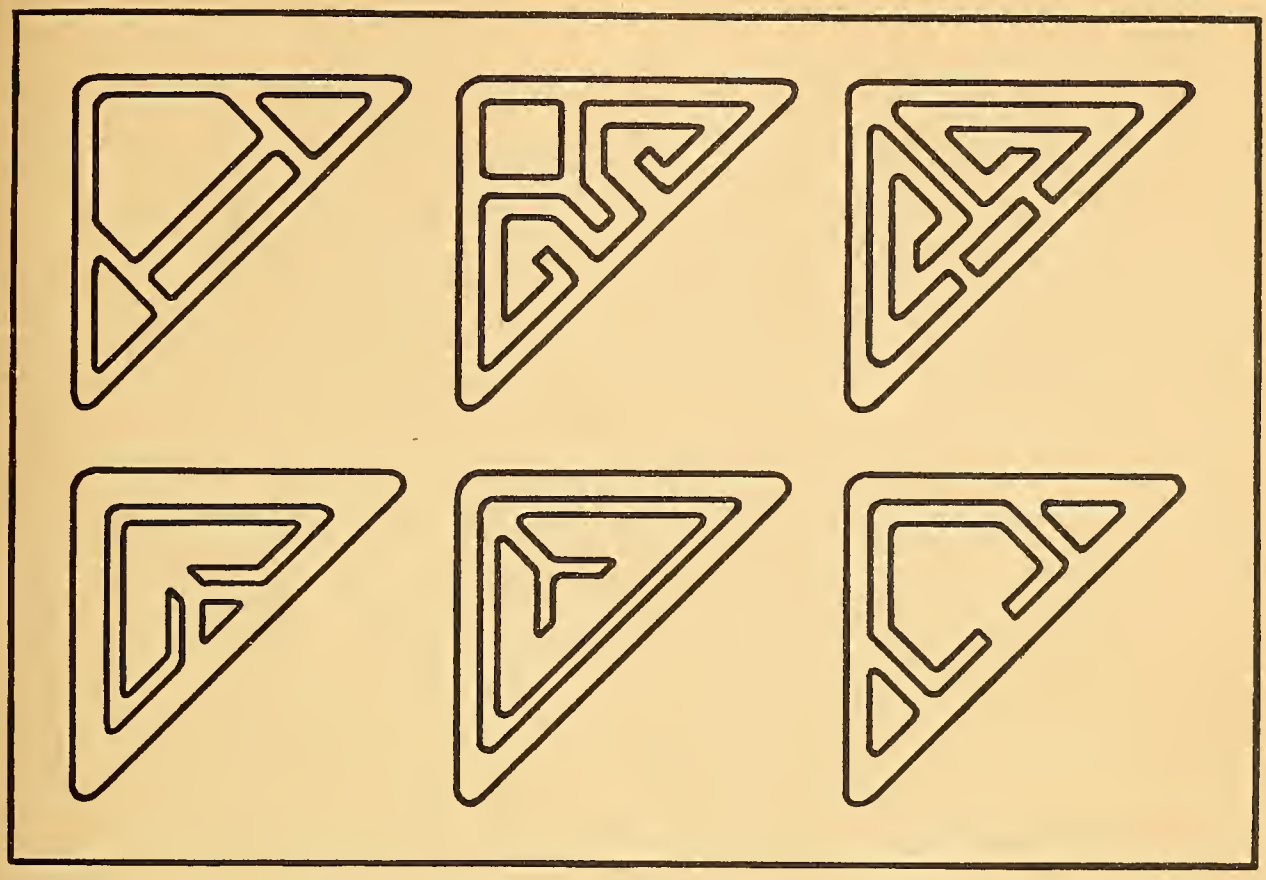
Fig. 19

The process of raising forms in thin metal is very interesting and not very difficult, unless carried to extremes. This process comprises all the forms, from very shallow trays to deep bowls, and even teapots and pitchers. The latter, however, are entirely too difficult for elementary work, and the student should content himself with making such objects as appear on pages 35 and 37 of this book. The base of the candlestick No. 7, on page 35, is simply a shallow bowl. In making such a bowl, the first step is to make a profile drawing of the object just the size you wish it to be when completed. A piece of copper about 20 gauge should be used. By means of a string, measure the distance on the drawing from the centre of the base to the top edge. This distance represents the radius of the circle to be drawn upon the copper. Another circle should be drawn from the same centre, showing the size of the base of the bowl. Figure 19 shows the method of raising the form by means of metal anvils held in place by the iron bench vise. Various anvils will be necessary, according to the shape of the object under construction, and several hammers can be used advantageously. A little experience in this work will suggest precisely the tool for any given purpose.

As often as the metal becomes hardened it should be annealed by heating it until it is red hot and plunging it into cold water. It is then in condition to work upon again. During the process of raising, the edges will become very irregular and will need to be trimmed. Mark the height all the way around the object, and trim off with a small pair of shears, finishing the edge with a file and emery cloth, so that it will be perfectly smooth. Consult your instructor often in all of these processes, and follow his advice carefully. It will save you many disappointments in beginning metal work, and his experience will enable you to accomplish much more than if you attempt to be too original.

# A MATCH SAFE

The lower drawing on page 33 is a working drawing for a match safe, and the upper drawing shows a perspective view and two schemes for decorating the sides. The dimensions are to be supplied by the pupil, according to the size of the match box chosen. Study the drawings carefully and note that a different base has been used in the perspective view from that in the working drawing. Make a drawing of a match safe to suit your purpose and work it out in thin copper or brass, after submitting your design to the instructor.



# BLOTTER CORNERS

Metal corners for a desk blotter offer a very interesting problem and are not very difficult. The designs given on this page may be etched or repousséd on copper, brass, or silver, of about 20 gauge. A pattern for blotter corners is shown in Book Five, page 26, of this series. The student will find many designs in the other books of the series which will help very materially in his work in wood and metal. Review the various processes concerned, namely, sawing, filing, etching and repousséing. Be very careful to remove all roughness from the edges, so the hand will not be cut in passing over the blotter corners.

# DESIGNING AND MAKING LETTER OPENERS

The designs on page 32 and other similar ones may be suitably worked out in copper or brass. The decorations may be etched and enameled, or simply etched. Decide upon the design you wish to use and mark out the shape upon the metal. It should then be sawed out, being careful at all times not to cut inside the line. Smooth up the piece with a file, working the edges down till they are smooth, but not too much rounded. The blade should be made thinner at the edges than in the middle, and thin toward the point. The edge should not be made sharp. After the piece is completed in this manner the design for etching may be traced upon the copper. Follow the general directions for etching given on page 28. As the enamel used on metal work requires great heat, it is not a practical thing for school use. However, a very desirable substitute may be had in the form of bath-tub enamel, which comes in cans. It is white, but may be tinted with any color by using artists' oil colors. The part to be covered with enamel is filled and allowed to dry. The enamel is then worked down to a smooth surface by means of pumice stone. Lacquer suitable for copper or brass can then be put over the surface of both metal and enamel. This will be found to be very durable, and is capable of very beautiful results.

# DESIGNS FOR LETTER OPENERS

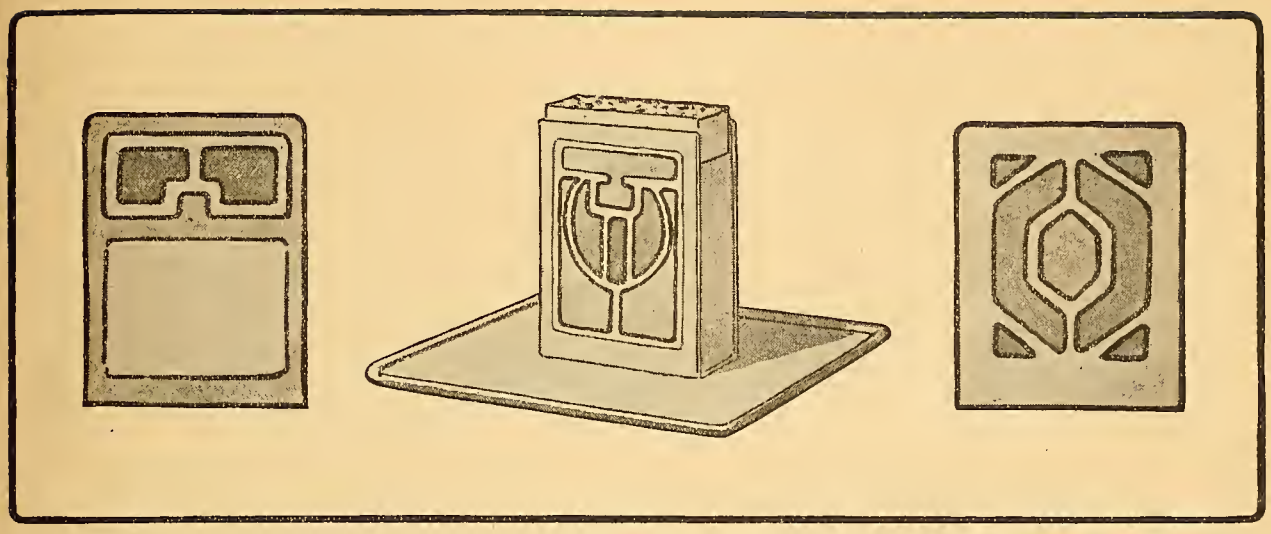


Fig. 20

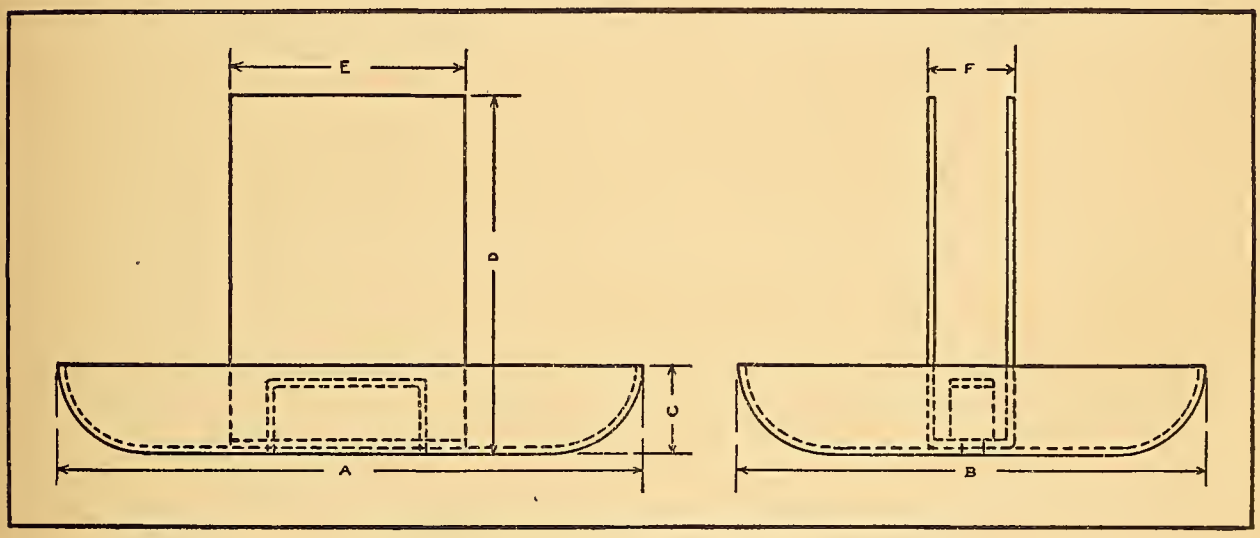



Fig. 21

# CANDLESTICK AND SHADES

On page 35 are several designs for candlesticks and shades. These shades may be used either for candles, lamps, gas or electric lights.

Fig. 1 shows the pattern for the finished shade shown in Fig. 5. Fig. 2 shows the pattern of the completed one in Fig. 3. Fig. 4 is a support which may be put over a gas jet or electric light bulb, or lamp, to hold the shade in place. The top of this support must be made of the proper size to fit the top of the shade. Diagram 1, page 34, shows the method of laying out pattern 1, on page 35. It may seem rather difficult, but it is about the only safe way to lay out the pattern for any size or shape. The size of the two circles in the diagram must be determined by the size of the lamp or other fixture to be fitted. Draw these two circles concentric, as shown, and draw diameter 1-2.

From 1, 3, 4 and D project downward to 5, 7, 8 and 6. Draw 5-6 and 7-8. Draw 5-7 and 6-8, extending them until they intersect at 9. Set off 15 degrees from the diameter at c-d, which is 1/24 of the circumference. With 9-5 as radius, describe a circle, and with the same centre, and a radius equal to 9-7, describe another circle. From any point on the greater circumference set off C–D 25 times. 24 of these divisions represent the circumference of the circle after the shade is completed. (See Fig. 1, Page 35.) The remaining division is space left for riveting.

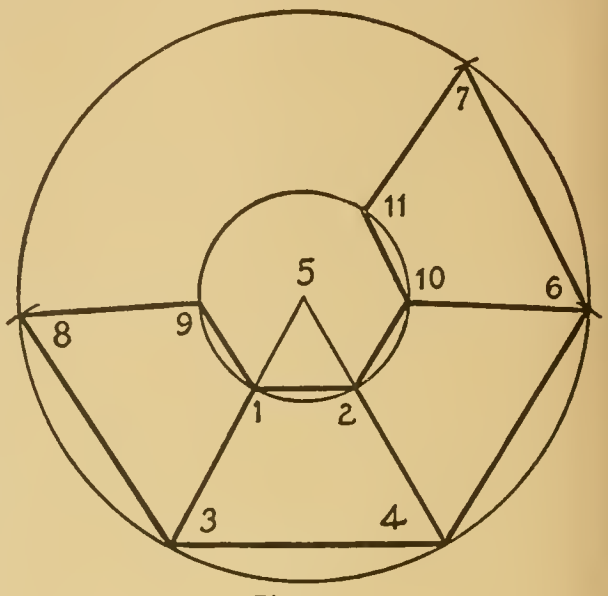


Diagram 2

Diagram 2 shows the method of laying out pattern 2. Draw one side 1-2-3-4, the desired size and shape. Extend the lines 3-1 and 2-4 until they intersect at 5. With 5 as centre and 5-3 as radius draw a circle. With the same centre and 5-1 as radius draw another circle. Set off the distance 3-4 upon the circumference of the larger circle in points 6, 7 and 8. Set off the distance 1-2 on the smaller circle in points 9, 10 and 11. Draw the lines 8-9, 9-1, 3-1, 8-3, etc., completing the figure. Allow a small margin on one of the sides as in Fig. 2, for riveting.

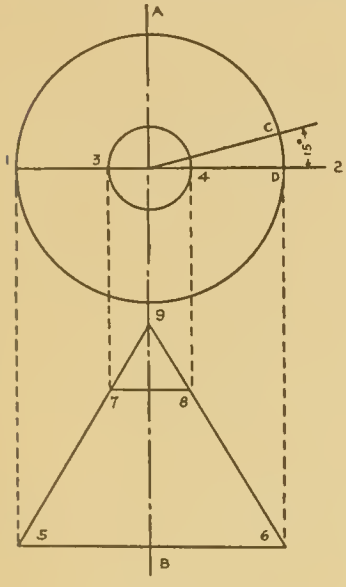


Diagram 1

The decorations on these shades may be made by puncturing, piercing, or etching. Review these processes on pages 27 and 28. For making the candlestick, in addition to the other processes, you will need to review soldering, riveting and raising. The base of the candlestick, Fig. 7, is raised similar to a shallow bowl from the flat piece of metal shown in Fig. 10. The handle is shown in Fig. 11. The rim around the top of the candlestick, Fig. 6, is raised slightly like a very shallow bowl, and the centre cut out the size of the candle. It is then soldered to the top. The base of the candlestick, Fig. 8, is made from a square piece and raised like the tray on page 37. The receiver for the candle may be made of tubing, or may be made of bending a piece of metal the required shape and soldering or riveting it up the side. The receiver for the candle may then be soldered to the base, and the handle either soldered or riveted to both.

# SIMPLE TRAYS AND BOWLS

Figures 1, 2 and 3 on page 37 show the very simple method of making shallow trays of any shape. Treat the centre of the tray as though it were a small bowl and disregard for the time being the remaining surface which is to receive the decorative border. Mark out very carefully the shape of this depression, and review the process of raising on page 30. Decide upon the decoration and apply it to the surrounding surface, as shown in Figures 1, 2 and 3. This decoration may then be etched or done in repoussé. Study the processes involved before attempting the work. Figures 9 and 10 show two modifications of a border which may be adapted to any of these metal problems. Figures 4 and 5 are simple forms of bowls, and Fig. 6 is a similar form with the addition of a lid. This lid is made from a flat piece slightly raised in the centre, with a narrow circular band soldered to the bottom to hold it in place. The ink pot, Fig. 8, is made first as a bowl, like Fig. 5. It is then inverted and soldered to a bottom piece, and the top cut out, after which a rim may be put around the top and a cover made, as for Fig. 6. Fig. 7 shows a casserole and cover.


1
2
3
4
5
6
1½"
7
8
1½"
5¾"
9
2½"r
10
5
2⅞"
4¾"
11
12

Earthenware casseroles can be bought at slight expense and make very desirable cooking utensils. The cover is a very interesting metal problem. It is made like a very shallow bowl, the edge being turned over to fit the shape of the casserole. A handle is then cut out and riveted on, and a suitable decoration may be applied, or it may be left plain. The inside of the lid should be plated with silver.

# A HANGING LANTERN OF BRASS OR COPPER

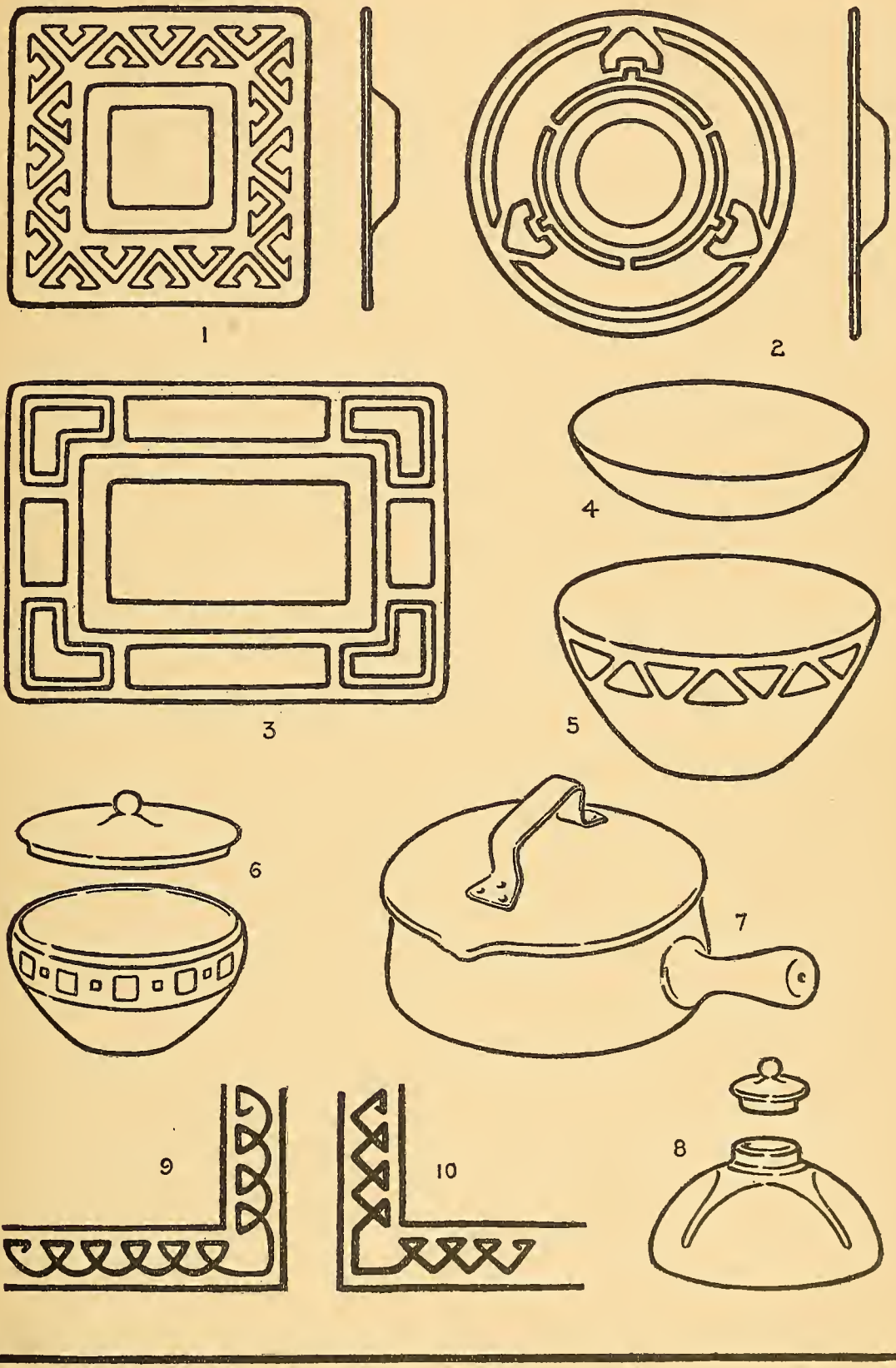
Page 38 shows an interesting way for students to arrange their drawings before carrying them out in material. At the right is a perspective view of the lantern as it will appear in use. This kind of lantern is very satisfactory where electric lights are used, as an electric bulb may be suspended inside the lantern and the wire carried through the top and up along the chain. Colored glass may be inserted for the sides, making a very interesting spot of color in the room. At the bottom of the page is a pattern for the four sides. It will be noticed that on the pattern the small decorative scheme at the top has not been repeated on the four sides, as would be necessary in the completed lantern. Another design for this same part is shown toward the top of the page. In the middle of the page are given the two patterns necessary for the construction of the top. All patterns should be cut out of the metal on the *solid* lines and bent on the *dotted* lines to fit into shape. The two parts of the top should be riveted together. The four sides should be folded together and riveted. The small flanges left at the top of the pattern are for riveting the sides to the top. The projections at the bottom are for bending inward to hold the glass after it is inserted. An interesting effect of color may be produced upon the copper by painting it over with a solution of one part perchloride of iron and two parts of water, which, after it is dry, may be partially rubbed off, thus producing a mottled green color which gives the appearance of age. The glass inside should extend high enough to cover the entire design. The small ventilators in the top should be cut on the line of the pattern and slightly raised with the peen of a hammer.

# MAKING WATCH FOBS

Some very easily made watch fobs are illustrated on page 39. The drawings are full size. The material needed is copper, brass or silver, and a piece of thin leather, which may be obtained in a variety of colors. The decorations may be pierced, or etched and colored, or enameled. For description of each of these processes see pages 27 and 28. As in all the other work in materials, the first step is to decide upon a design and make a drawing. Lay out the material for each part, cut it out, and dress it up to the exact size and shape. Before doing the actual work of making the fob it will be necessary to understand the processes (sawing, filing, drilling, etching, soldering and enameling) which are given on pages 27 and 28. Near the centre of page 39 is a design for the pendant of the fob, showing three views. This provides for a button on the back of the metal part, so that it may be buttoned through the leather, instead of suspended from a slot like some of the others. Where students have not had sufficient practice or opportunity to make chains, the plan given at the lower right-hand side of the page will be found very satisfactory.

# MAKING BROOCHES AND BELT PINS

The material needed for making these objects is copper, brass or silver. It is hardly worth while to make the backs, as they can be bought so cheaply. Review the processes of sawing, filing, soldering, etching and enameling. The enameling must be done last, as the heat of soldering would melt the enamel.


1
2
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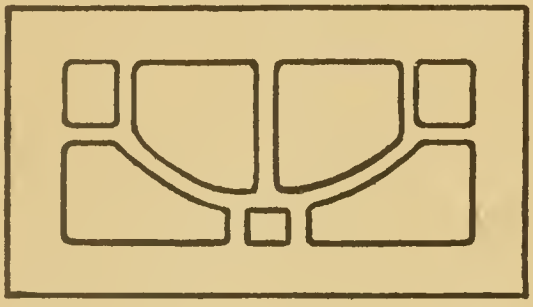
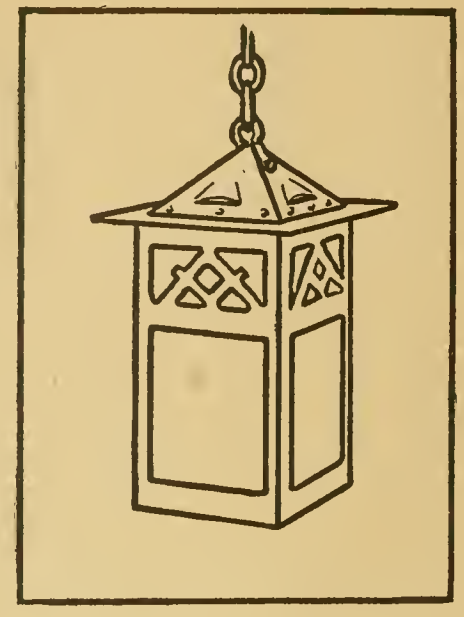
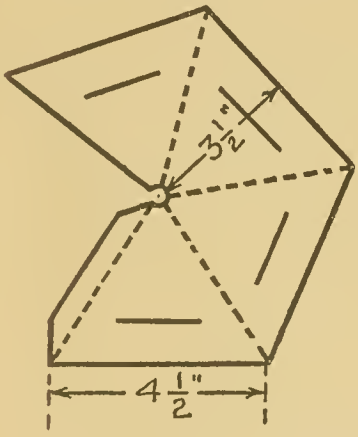
10

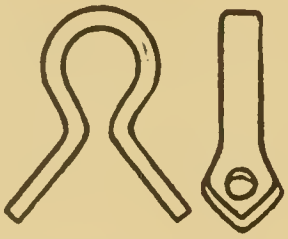
# A HANGING LANTERN OF BRASS OR COPPER



DESIGN FOR SIDES





DETAIL OF HANGER FULL SIZE